ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Draft Environmental Impact Statement

Part I OVERVIEW Volume 1 of 1

JUNE 1975
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C. 20240

ALASKA NATURAL GAS
TRANSPORTATION SYSTEM

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June 1975

This Draft Environmental Impact Statement has been prepared under the provisions of Section 102(2)(C) of the National Environmental Policy Act of 1969 (P.L. 91-190).

Review and comment regarding the adequacy of the statement are invited.

To assure receipt and full consideration of all comments, communications should be addressed to:

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Note for Readers

This environmental impact statement has been prepared in seven parts as follows:

Part I	Overview (1 Volume)	Part V	North Border (3 Volumes)
Part II	Alaska (3 Volumes)	Part VI	Alternatives (2 Volumes)
Part III	Canada (3 Volumes)	Part VII	Consultation and Coordination (1 Volume)
Part IV	West Coast (4 Volumes)		

The first five parts are geographically oriented and are presented in parallel format. The following subject groupings are covered sequentially in each Part:

1. Description of the proposal.
2. Description of the environment.
3. The environmental impact of the proposed action.
4. Mitigating measures included in the proposed action.
5. Any adverse effects which cannot be avoided should the proposal be implemented.
6. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.
7. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.
8. Alternatives to the proposed action.
9. Consultation and coordination with others.

Part VI, Alternatives and Part VII, Consultation and Coordination develop their subjects in a different grouping than the geographic parts.

A reader may elect to pursue his particular interest by selecting the parts to which he refers rather than search all parts. For example, a reader interested only in his area, say Montana, could use Part I for the big picture and Part V, North Border for the coverage of his specific area. In the same manner, a reader interested in ways of transporting natural gas could refer to Part VI, Alternatives and satisfy his needs.

Following is a brief description of the coverage of each part:

Part I Overview - The Overview covers the Arctic Gas System proposal in its entirety. It will be most useful to those readers who want a system view and a broad concept of anticipated environmental impacts of the 6,280 mile pipeline project.

Part II Alaska - This part covers the 195 mile proposal of the Alaskan Gas Arctic Pipeline Company originating at Prudhoe Bay and terminating at the Alaska-Yukon Border.

Part III <u>Canada</u> - This portion of the environmental impact statement analyzes the 2,430 mile pipeline proposal of Canadian Arctic Gas Pipeline, Ltd., beginning at the Yukon-Alaska Border and proceeding generally southward to Caroline Junction in Alberta. At this point, the proposed pipeline forks, one leg entering Idaho, near Kingsgate, British Columbia, and the other entering Montana, near Monchy, Saskatchewan.

Part IV <u>West Coast</u> - This part analyzes two pipeline proposals. One, a 917 mile pipeline, is sponsored by the Pacific Gas Transmission Company and passes through Idaho, Washington, and Oregon to Antioch, Contra Costa County, California. The other, a 1,119 mile pipeline, is proposed by Interstate Transmission Associates (Arctic), and passes through Idaho, Oregon, Nevada, and terminates at Cajon, San Bernardino County, California.

Part V <u>North Border</u> - This part is an analysis of the 1,619 mile pipeline proposed by the Northern Border Pipeline Company. It covers the area from the United States-Canada Border crossing in Montana, across North and South Dakota, Minnesota, Iowa, Illinois, Indiana, Ohio, a short distance in West Virginia, and terminates near Delmont, Pennsylvania.

Part VI <u>Alternatives</u> - This part covers a no action alternative, deregulation, other natural gas sources, alternative energy sources, modes of transportation, route alternatives, pipeline size alternatives, and a special section on a major system alternative of crossing Alaska by pipeline and then converting gas to a liquefied state for transportation to lower 48 States by sea.

Part VII <u>Consultation and Coordination</u> - This part describes and discusses the efforts made by the Department of the Interior to consult with and coordinate its work in the development of this statement. It includes the gathering of basic information for analysis, public meetings, and efforts which have and will be made to assure that environmental impacts are adequately treated.

SUMMARY

(X) Draft ( ) Final Environmental Statement
Department of the Interior, Alaska Natural Gas Transportation System
EIS Task Force

1. Type of action: (x) Administrative ( ) Legislative

2. Brief description of action: The action pending is granting right-of-way permits for Federal lands. A 6,280 - mile underground pipeline has been proposed to transport natural gas from Prudhoe Bay (Alaska) to markets in the lower United States. The pipeline will cross all or portions of Alaska; Yukon Territory, Northwest Territories, British Columbia, Alberta, and Saskatchewan (Canada); and Idaho, Washington, Oregon, Nevada, California, Montana, North Dakota, South Dakota, Minnesota, Iowa, Illinois, Indiana, Ohio, West Virginia, and Pennsylvania in the lower United States. As proposed, all activities necessary for pipeline construction and operation will be phased over an 8-year period. For example, if necessary governmental actions are completed, work could begin in 1976 and be completed by 1983. Of all lands traversed by the proposal, 995.5 miles will involve lands and waters under the jurisdiction of five Federal agencies who must issue right-of-way permits. Other permits or licenses also must be issued by Federal agencies before construction may begin or the project becomes operational.

3. Environmental impact and adverse environmental effects: Because of the linear nature of the proposal, a wide spectrum of environmental impacts will occur if the pipeline is built. The statement includes analyses of impacts of the project on the environment, and impacts of the environment on the project, as follows: climate; topography; geology; soils; water resources; vegetation; fish and wildlife; ecological considerations; socio-economic; land use; paleontological, archeological, and historic; recreation and esthetics; air quality; noise; and special hazards.

4. Alternatives considered: Alternatives covered include no action, alternative natural gas sources, deregulation, alternative energy sources, modes of transportation, major route alternatives, pipeline size alternatives, and a special section on a major system alternative of crossing Alaska by pipeline and then converting gas to a liquefied state for ocean transport to the lower United States. Specific route and size alternatives are discussed and analyzed for the four geographically oriented parts of the draft statement (Alaska, Canada, West Coast, and North Border).

5. Comments have been requested from: Comments have been invited specifically from: Canada, some 40 Federal (US) agencies, Governors and Congressional members from 16 States, State and Area Clearinghouses from 16 States, over 100 identified private organizations, 6 applicant companies, the Federal Power Commission Service List (over 500 interested parties) and nearly 100 individuals on record. Many other groups and individuals are expected to review the EIS for comment.

6. Draft statement made available to CEQ and the public: June 1975.

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1.OV Description of the Proposed Action

Introduction

A major oil find on the North Slope of Alaska was proven in 1968 by the Atlantic Richfield Company. This 200-square-mile area known as the Prudhoe Bay Field contains an estimated 26 trillion cubic feet of natural gas both in solution with the oil and as free gas. Following the proving of this discovery three companies formed a study group to plan and design pipeline for transporting the oil. Subsequently, more companies joined this group and in 1970 the Alyeska Pipeline Service Company was formed to operate and construct an oil pipeline. This company applied to the Federal Government for the necessary permits and rights-of-way to construct a line from the Prudhoe Bay Field to Valdez, a deepwater port in southern Alaska on the Valdez Arm of Prince William Sound. With the passage of the Mineral Leasing Act of 1920 amendments and trans-Alaska oil pipeline authorization in November 1973, Congress authorized and directed the Federal agencies involved to issue the necessary permits and rights-of-way to the Alyeska Company so that construction of the Trans-Alaska Pipeline System (TAPS) could begin. As a result, actual pipeline construction began in the winter of 1974-75. If TAPS

pipeline construction is completed as scheduled, transport of oil through the line could begin in 1978.

The volume of gas that will be immediately available for transmission cannot be determined at this time. Production rates and quotas must be established to assure maximum recovery of both the oil and gas. These production rates and quotas will be set by the Alaska Department of Natural Resources, Division of Oil and Gas, after a comprehensive reservoir analysis based on full-scale production is completed.

It is estimated that 1/3 of the gas is in solution with the oil and the balance is in a gas cap atop the oil reservoir. Therefore, gas will be produced when the oil wells are put into operation. One estimate of the volume of gas that will be produced in solution with the oil is 1.6 billion cubic feet per day. Since Alaska State law prohibits the flaring of gas (burning gas in the open atmosphere), any gas produced must be utilized; it can either be sold or reinjected into the pool. Until the reservoir analysis is complete, the gas will be reinjected. Appreciable quantities of gas will not be available from the Prudhoe Bay Field for at least one year after the Alyeska Project begins operation.

A consortium of 27 companies has proposed that a 6,280-mile pipeline be constructed for the transportation of this gas from Prudhoe Bay to markets in the 48 conterminous States. The oil producers have entered into negotiating agreements with member companies of the consortium for the gas. The oil producers would gather, chill, compress, and deliver available gas to these companies. Gas would be delivered to a metering station at the start of the gas pipeline at a temperature of 25° Fahrenheit and a pressure of 1,600 p.s.i.g. (pounds per square inch gauge).

Before construction can begin on a gas pipeline, appropriate agencies of the Federal Government must grant a series of permits, authorizations, and approvals. Among the agencies with major involvement are the Federal Power Commission which must grant certificates for interstate gas sales and for the construction and operation of interstate pipelines, and the Department of the Interior which is responsible for granting rights-of-way across Federal lands. Since these are major Federal actions that will have a significant impact on the environment, this environmental impact statement has been prepared.

Although the environmental impact statement addresses itself to a route and right-of-way alignment, it is, at this

point, a corridor concept. The precise location of the gas pipeline cannot be determined until the level of engineering is advanced, and in some cases until the location is actually determined on the ground. By following a corridor concept adjustments in alignment of up to several miles on either side of the route discussed in this environmental impact statement can be made without the necessity of treating all route adjustments as alternatives to the proposal.

The gas pipeline, in terms of dollars, is reported to be the largest privately financed project in the world. Based on early 1975 estimates the cost of construction would be \$9.57 billion. Terminal points of the proposed pipeline will be Antioch, California; Cajon, California; and Delmont, Pennsylvania.

1.OV.1 Purpose

A. Function of the Pipeline

Six companies have made application to the Federal Power Commission and the Department of the Interior for the necessary authorizations, certificates, and permits to construct a pipeline to transport gas from the Prudhoe Bay Field in Alaska and from the Mackenzie Delta area of the Northwest Territories, Canada, to markets in the conterminous 48 States. Pipeline termination points in the conterminous United States would be near Pittsburgh, Los Angeles, and San Francisco. A seventh company has made application to the appropriate agencies of the Canadian Government for authorization to construct that portion of the line in Canada. These companies, Alaskan Arctic Gas Pipeline Company, Canadian Arctic Pipeline Company Limited, Northern Border Pipeline Company, Pacific Gas Transmission Company (PGT), Pacific Gas and Electric Company (PG and E), Interstate Transmission Associates (Arctic) (ITAA), and Southern California Gas Company (SoCal), propose to construct approximately 6,280 miles of pipeline.

1) Total Reserves

The Prudhoe Bay Field contains a proven reserve of 26 trillion cubic feet and the Richards Island and Parsons Lake areas of the Mackenzie Delta estimated reserves are in the range of 13 trillion to 15 trillion cubic feet. In addition to the Prudhoe Bay Field, the State of Alaska estimates a speculative resource of 41.8 trillion cubic feet on the North Slope and an additional 13.5 trillion cubic feet in offshore deposits under the Beaufort Sea. Another estimate places the level of gas on the North Slope as high as 300 trillion cubic feet. Estimates of potential recoverable gas in the Mackenzie Delta-Beaufort Basin Region in Canada are also substantial, one estimate being 75.4 trillion cubic feet and another being 100 trillion cubic feet.

2) Daily Volume to be Transported

Planned delivery from the Alaska pipeline is 2.25 billion cubic feet per day after 1 year of operation and 4.5 billion cubic feet per day after 5 years of operation. When completed the pipeline will have a capacity of 5.9 billion cubic feet per day. The Northern Border leg to Delmont,

Pennsylvania will have an estimated capacity of 3.5 billion cubic feet per day; the Pacific Gas Transmission and Pacific Gas and Electric leg to Antioch, California and the Interstate Transmission Associates (Arctic) and Southern California Gas Company leg to Cajon, California will each have capacities of 1.2 billion cubic feet per day. The excess capacity is even greater since approximately one-half the total volume to be transported is for the Canadian markets. This volume would be taken off in the Trans-Canada Limited System with a tap at Empress, Saskatchewan between Caroline Junction and Monchy. As a result the volume reaching the United States after 5 years would be 2.25 billion cubic feet per day plus whatever volume Canada might determine available for export. This means that the lines proposed for construction in the United States would be built with an excess capacity of 3.65 billion cubic feet per day.

On an annual basis the proposed volume to be transported after one year of operation is .8 trillion cubic feet and the annual volume after 5 years of operation is 1.6 trillion cubic feet. As proposed the volume of gas to be transported after 5 years of operation would be divided between

production from the Prudhoe Bay field in Alaska and the Richards Island and Parsons Lake areas in Canada.

It is assumed that this excess capacity would be available to transport additional volumes of gas from the immediate Arctic Region or from fields that may be developed within reasonable proximity making a tap-in economical. This excess capacity could also be used to transport synthetic gas that may be produced from other sources.

B. Function of Related Facilities

Table 1.OV.1-1 summarizes the facilities of the entire Arctic Gas Pipeline System. To achieve maximum daily transmission volumes compressor stations and gas chilling facilities will have to be constructed along the line. In Alaska gas collection facilities including compressors and chillers will be constructed by the oil companies. No additional facilities will be constructed on the gas transmission line in Alaska until the delivery volume is increased beyond 2.25 billion cubic feet per day.

The natural gas to be obtained from the Prudhoe Bay field in Alaska is associated with oil production. At oil reservoir pressures over 4,000 psi (pounds per square inch)

Table 1.OV.1-1
Proposed and Potential Facility
Construction for Pipeline

Facilities	Alaska Arctic	Canadian Arctic	Northern Border	Pacific Gas Trans.[4,5]	Interstate Trans.[4,5]	Total
Compressor Stations	4[1]	40	30	4[6]	11	89
Refrigeration Chillers	4[1]	15	NA	NA	NA	19[2]
Air Exchange Chillers	0	21	30	NA	NA	51[2]
Stockpile Areas/Wharves	3	27	NA	NA	NA	30[2]
Air Fields	6	21	NA	NA	3	30[2]
Helipads	14	170	NA	NA	NA	184[2]
Measuring Stations	1	5	14	NA	3	23[2]
Communication Sites	9	80[3]	88	NA	NA	177[2]
Maintenance Sites	NA	NA	NA	NA	5	5[2]
Block Valves	9[2]	80	97	NA	61	247[2]
Miles Permanent Road	2	67	NA	NA	20	89[2,8]
Borrow Areas	16	70	NA	NA	NA	86[2]
Pressure Relief	NA	NA	NA	NA	NA	NA
Pressure Limiting	NA	NA	NA	NA	NA	NA
Off Line Delivery Taps	NA	4	11	40	1	56[2]
Totals	68[2,7]	533[2,7]	270[2,7]	44[2,7]	84[2,7]	997[2,7]

[1]Potential future construction
[2]Incomplete Total
[3]30 Communication sites will be in conjunction with compressor stations
[4]Numbers of all facilities not identified by applicant
[5]Includes segments in California
[6]At existing stations
[7]Two or more facilities may be combined at one site
[8]Not included in total
NA--Information not presently available

this gas, consisting primarily of methane, is dissolved in oil. As the oil rises in the well toward the surface and the pressure drops, the gas separates and the mixture of oil and gas is pumped out. Test wells drilled have shown a yield of 850 cubic feet of gas per barrel of oil. With a well output up to 23,000 barrels/day, approximately 2 million cubic feet per day of gas could be obtained from a single well. With the field in full operation the oil output will be 2 million barrels per day. Some of the gas (up to 4 million cubic feet per day) will be used for driving gas turbine pumps and other equipment in the oil field, and up to 41 million cubic feet per day will be sent to the first 4 pump stations of the Trans-Alaska oil pipeline. Approximately 1.5 billion cubic feet per day of gas will be left for disposal and this would be supplemented with other not-associated gas sources to provide the initial output of 2.25 billion cubic feet per day of pipeline gas if the proposed gas pipeline is built. Until the gas pipeline is built, the excess of associated gas will be reinjected into the oil reservoir.

The Prudhoe Bay oil field with the associated gas is estimated to extend 44 miles east to west and about 20 miles north to south. Multiple-well pads are built from which 6

to 16 wells may be directionally drilled to the reservoir. Initially there will be 57 pads but in the course of the oil field development as many as 80 additional pads may be required.

The oil mixture is piped above ground from the wells at 130° F to gathering centers where separation of oil and gas and preliminary cleaning of the gas take place. The separators have sufficient capacity to store gas at 50 psi for line purging. Initially there will be three gathering stations but this number will be increased to six in a fully developed field.

From the gathering stations the gas at about 600 psi pressure will be piped with pipelines varying from 22 inches to 42 inches to a gas disposal center.

Gas will be compressed by a series of centrifugal gas turbine-driven compressors. Twelve such compressors will be installed for the oil field operation for reinjection of the gas into the reservoir. These compressors will be staged to provide the high pressure (2,000 to 4,500 psi) required for gas reinjection. Upon switching operations from reinjecting gas (into the Prudhoe Bay field) to moving gas through a pipeline system to continental U.S. markets, the gas disposal center will perform the following functions:

partial gas storage; gas purification; gas compression; gas refrigeration; gas flow rate measurements; and gas flow control. Some of these functions, such as gas storage, gas purification, refrigeration and metering, will be specific functions associated with the gas pipeline system.

The gas will probably be stored in the condition received from the gathering centers. The storage capacity may not be larger but it must be sufficient to accommodate variations in well output as well as variations in gas delivery including occasional partial or complete emergency maintenance shutdown of the gas pipeline.

Purification of the gas will consist in the first stage of removal of hydrates and heavier hydrocarbons. Following this the gas will pass through a contact adsorption column or columns where primarily carbon monoxide, hydrogen sulfide and other sulfides will be removed.

Changes in the gas injection compressors will be necessary before they can be used for gas transmission. The compressors having been used for well injection might be re-tuned or new compressors might be added. This decision will probably not be made until the production rate of the oil has been ascertained.

The gas has to be refrigerated after compression but before entering the pipeline so that its inlet temperature is around 20° F. The refrigeration system will presumably be similar to that described for future compressor stations to be built when the pipeline flow rate exceeds 2.25 billion cubic feet per day. A gas-turbine driven refrigeration system using propane as a refrigerant will be installed for gas cooling.

The measuring station as described by Alaskan Arctic Gas Company will record the flow rate of the gas and will transfer the data to the gas pipeline control center.

The construction period for the total system is estimated to be eight years. During this period 81 compressor stations would be constructed, additional compressors would be added at four existing stations on a parallel line and modifications would be made on 13 other existing compressor units.

Since gas absorbs heat during compression, gas chillers must be added to reach or maintain desired temperature levels. North of Fort Simpson, Northwest Territories, Canada closed system propane refrigeration chillers would be used. This is the area of permafrost and the gas would be maintained at a temperature of 32° Fahrenheit or less to

maintain the integrity of the permafrost. Approximately 15 propane chillers would be constructed and south of Fort Simpson 51 air exchange coolers would be constructed.

C. Justification for Project

Currently, demand for gas exceeds production in the lower 48 States. To achieve a balance between supply and consumption in the past few years, interruptions of gas service, curtailments of firm deliveries, refusals to take on new customers and refusal to provide increased service to existing customers have been necessary. These actions were undertaken as the gas industry has been forced to respond to the shortage of gas; they have been carried out with due regard for human needs and to minimize the impact on the economy. There is now increased recognition that the gas shortage is serious and probably of long duration.

The projections in Table 1.OV.1-2 are from a report prepared by the Federal Power Commission.

Table 1.OV.1-2

Gas Supply and Demand Projections

(Volumes in Trillions of Cubic Feet)

Year	Gas Supply 1/	Gas Demand 2/	Shortage
1975	24.3	28.0	3.7
1980	24.7	33.4	8.7
1985	25.3	38.4	13.1
1990	25.2	45.3	20.1

1/ Chapter 9, Table 9-1, National Gas Survey, Federal Power Commission, 1974, (Case II Level).

2/ Chapter 7, Table 7-1, National Gas Survey, Federal Power Commission, 1974.

The Case II (conservative-realistic) supply estimates are based on a level of effort that exceeds that of the past 10 years and includes an assumption that Prudhoe Bay gas will be delivered to market. It is unlikely that actual supplies will reach the Case II level even with the delivery of gas from the Prudhoe Bay fields.

The supply of gas shown in Table 1.OV.1-2 includes production from Alaska. Volumes from Alaska for the years shown are 4.4, 5.6, 5.6, and 4.7 trillions of cubic feet,

respectively. These volumes include both Prudhoe Bay and Cook Inlet sources. Since no production from Prudhoe Bay will be available to the market in 1975 the estimated shortage for that year is even larger than projected. This is probably true for 1980 as well.

Any increase in the gas supply in the lower 48 States will provide greater flexibility in the economy and alleviate the interruptions, curtailments, and refusals of service. Delivery of additional gas from Alaskan sources would further ease the shortage.

There is sufficient excess capacity in the proposed system to handle an additional 1.3 trillion cubic feet annually. Thus, the system can readily accommodate additional sources of gas without additional construction.

1.OV.2 Location

A. Specific Route

The portion of the proposed pipeline to be constructed by the Alaskan Arctic Gas Pipeline Company originates on the southwest shore of Prudhoe Bay, Alaska. From that point it runs southeasterly along the coastal plain 3 to 30 miles from the south shore of the Beaufort Sea. At Milepost 61 on the west bank of the Canning River the route enters the Arctic National Wildlife Range. From that point the route climbs to an elevation of almost 800 feet in the foothills of the Sadlerochit Mountains and then drops back to an elevation of 350 feet at the Egaksrak River at Milepost 161. The remainder of the route is across level terrain and passes within 5 miles of Demarcation Bay before entering Canada.

In Canada, the Canadian Arctic Gas Pipeline Company proposes to continue the line parallel to the coast for approximately 300 miles; the line then swings in a southerly direction along the western edge of the Mackenzie Delta. At Fort McPherson the line assumes an easterly direction and crosses to the east bank of the Mackenzie River at Milepost 453. The line continues easterly to Travaillant Lake Junction and then swings to the south, crossing to the west

bank of the Mackenzie about 45 miles downstream of Fort Simpson. The line then continues southeasterly to Caroline Junction.

At Caroline Junction, Alberta, the line forks and one leg assumes an easterly direction through Alberta and then southeast to Monchy, Saskatchewan. The other fork proceeds south, swinging southwesterly to Kingsgate, British Columbia. The line from Monchy, Saskatchewan will be continued by the Northern Border Pipeline Company. It will continue across the northeast corner of Montana, southwestern North Dakota, and northeastern South Dakota, passing within 3 miles of Aberdeen.

The route crosses southwestern Minnesota, northeastern Iowa, and turns in a more easterly direction at the Illinois boundary. It cuts across the northern quarter of Illinois, extreme northern Indiana, continuing in an easterly direction across Ohio, 8 miles of West Virginia, and terminating at Delmont, Pennsylvania about 20 miles south of Pittsburgh.

The line from Caroline Junction to Kingsgate enters the United States near Eastport, Idaho and forks again. The two West Coast legs are parallel for 206 miles to a point south of the Snake River in Washington. The west leg angles off

southwesterly through southeastern Washington, then southerly through Oregon and northern California, terminating at Antioch, California 35 miles east of San Francisco. The Pacific Gas Transmission Company (PGT) and the Pacific Gas and Electric Company (PG and E) will construct this line from Eastport, Idaho to Antioch; the new line will parallel an existing gas pipeline of the same companies, except for a 21.4 mile stretch in Oregon.

The east leg turns south, passing through eastern Oregon, western Nevada and on to Cajon, California about 60 miles east of Los Angeles. Interstate Transmission Associates (Arctic) (ITAA) and the Southern California Gas Company (SoCal) will construct the east leg from Eastport to Cajon; this means that between Eastport and the separation point just south of the Snake River, the pipeline constructed by ITAA will parallel both the existing and new PGT-PGE pipelines.

The proposed alignment is shown on the route map in Figure 1.OV.2-1, which follows.

Figure 1.OV.2-1. Overall Systems Map.

B. Regional Description

1) Parks, Forests, and Recreation Areas

If the pipeline is constructed along the route as proposed, it will cross or pass near designated parks, forests, and recreational areas, as well as historical and archaeological sites. Details of the areas that will be crossed or affected are presented in Chapters 1 in each of Parts II, III, IV, and V of the Environmental Impact Statement.

The proposed route crosses the 14,000 square mile Arctic National Wildlife Range in Alaska. It travels down the eastern face of the Rocky Mountains in Canada where it generally parallels suspected migration paths of early man. As it continues south and east in the 48 States, the line intersects 9 designated park and recreation areas that have been acquired with Federal aid and intersects the route of the Lewis and Clark Expedition, which is under study for inclusion in the National Trails System. The proposed line crosses three rivers that could be found suitable for inclusion in the National Wild and Scenic Rivers System and portions of three Indian reservations in the lower 48 States. Previous archaeological studies and discoveries along the eastern portion of the route have revealed the

presence of early rather highly developed cultures of some permanence as evidenced by mounds and village sites. It seems reasonable that evidence of at least nomadic penetration may exist at the upper part of the line. The location of the route in terms of the history of the development of this country is thus important.

The West Coast legs cross 13 National Forests and public domain lands. No State or local park, forest or recreation areas have been identified as being crossed by the proposed route. The route crosses at least one potential National Wild and Scenic River, crosses the designated Pacific Crest Trail and two potential National Scenic Trails. Historically, the area is important in the expansion of the country; fur trading and mining areas, military installations, and railroads are all transected by the route.

2) Other Pipelines and Power Facilities

The hydrocarbon field at Prudhoe Bay is the source for both this proposed gas pipeline and the Alyeska oil pipeline. The proposed gas line would begin approximately 4 miles north of the starting point for the Alyeska line.

Other than privately owned facilities to serve the Prudhoe Bay operation, there are no utility lines, roads, or similar facilities that would be intersected along the entire route in Alaska.

In Canada's Yukon and Northwest Territories, as in Northern Alaska, there are no power facilities or pipelines crossed. Through the province of Alberta, the proposed gas pipeline would generally parallel and have connections with four existing gas transmission lines in Canada. (Further information and a map can be found in this volume under 2.OV.11.D, Transmission Facilities.) The proposed gas pipeline would also run close to or parallel numerous petroleum pipelines in Alberta and Saskatchewan.

Within the conterminous 48 States there will be 79 crossings of existing gas, oil, LNG, and petroleum products lines. Although the total number of power lines to be crossed has not been identified, 43 are known. Crossings of transportation facilities known at this time include 126 railroads, 17 interstate highways, 56 U.S. highways and 120 State and other roads. There will also be over 1,500 crossings of water courses with approximately 100 being considered major. Additional information on these crossings

including maps and tables is contained in Chapter 1 of Parts II, III, IV, and V.

C. Specific Location of Plants, Stations, and Related Facilities

The location of all facilities to be constructed for each segment of the line are shown on the following series of maps, Figures 1.OV.2-2, 3, 4, 5 and 6. Table 1.OV.1-1 in the preceding section summarizes the number of major facilities that will be constructed along each segment. It is important to note that single sites such as compressor stations may include several of these facilities.

D. Relationship to Potential Energy Sources

Although the Prudhoe Bay Field is the first oil and gas field being developed in the North American Arctic, other potential fields have already been discovered. This pipeline could provide a possible transmission source for other fields, or it could establish a corridor for possible future pipelines. A similar situation prevails in Canada

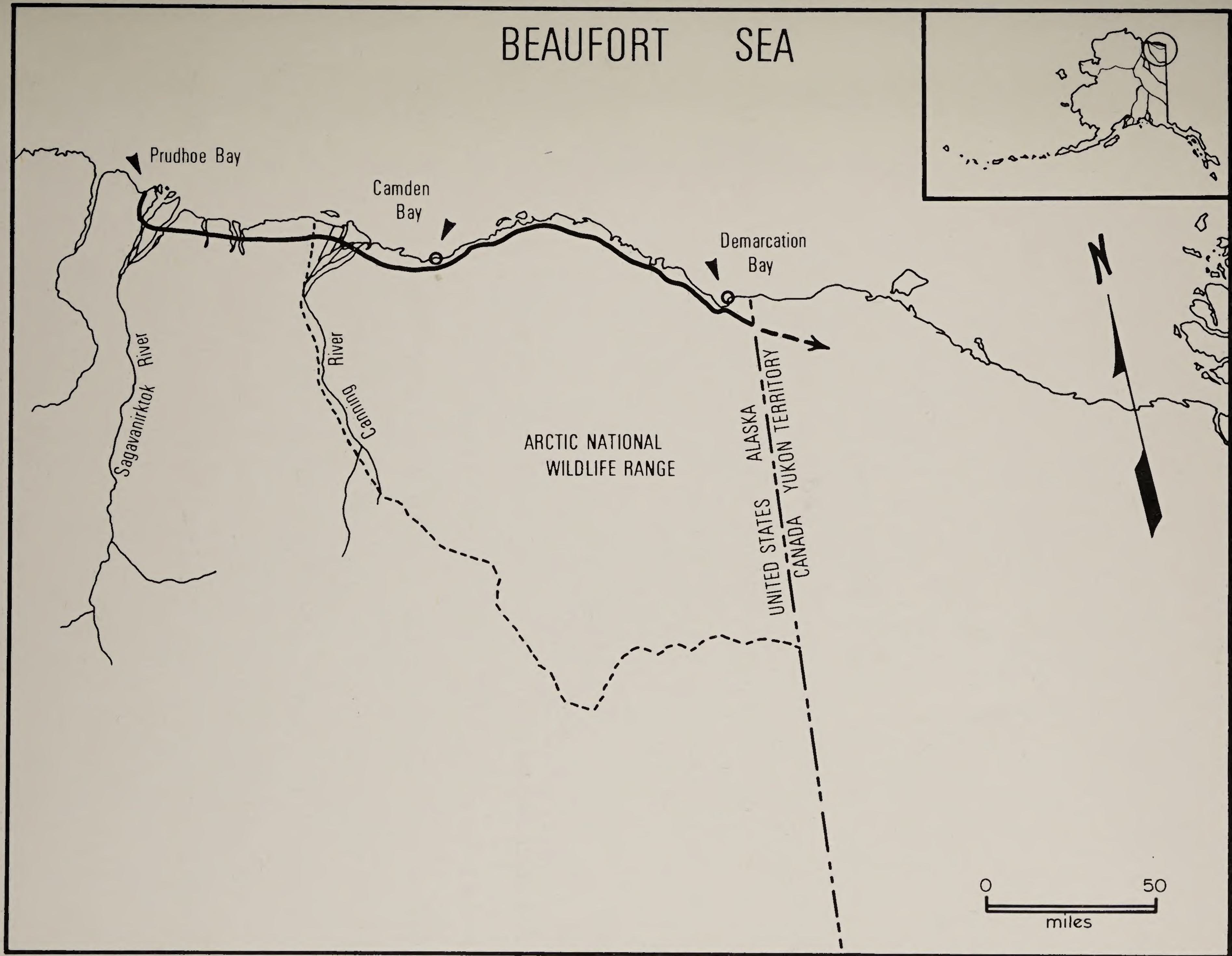
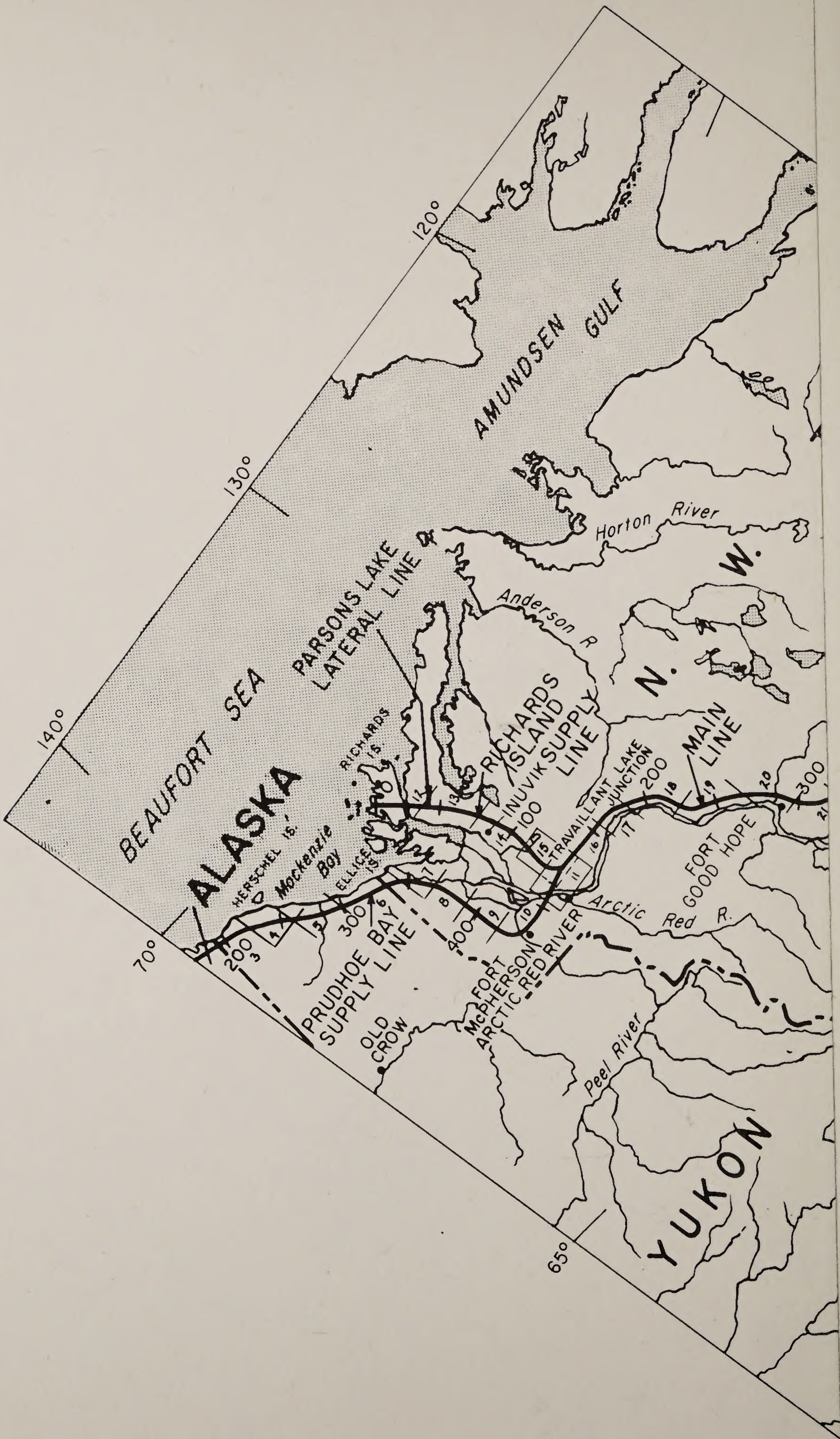
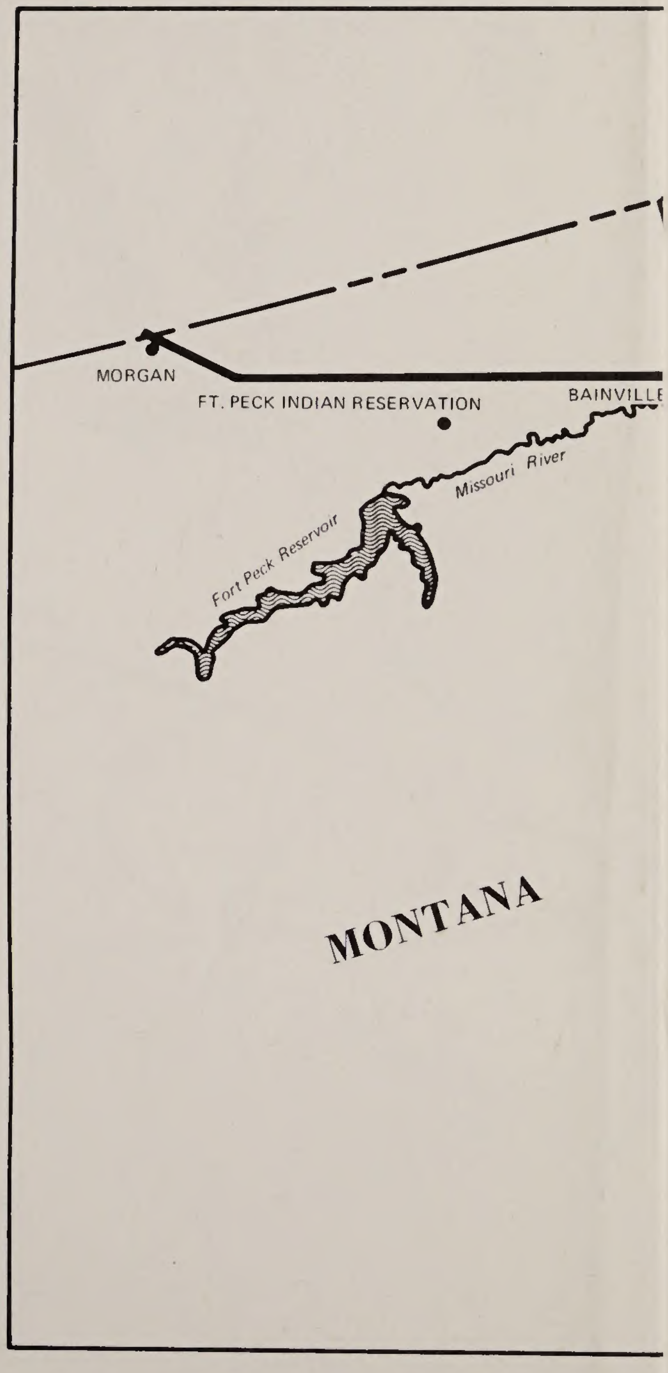


Figure 1.OV.2-2. Pipeline Facilities Location Map — Alaska.

Figure 1.OV.2-3. Pipeline Facilities Location Map – Canada.



BEAUFORT SEA
AMUNDSEN GULF
ALASKA
HERSCHEL IS.
Mackenzie Bay
ELLICE IS.
RICHARDS IS.
PARSONS LAKE LATERAL LINE
RICHARDS ISLAND SUPPLY LINE
INUVIK
TRAVAILLANT LAKE JUNCTION
MAIN LINE
FORT GOOD HOPE
PRUDHOE BAY SUPPLY LINE
OLD CROW
FORT McPHERSON
ARCTIC RED RIVER
Arctic Red R.
Peel River
Horton River
Anderson R
N. W. T.
YUKON
140°
130°
120°
70°
65°


MORGAN
FT. PECK INDIAN RESERVATION
BAINVILLE
Missouri River
Fort Peck Reservoir
MONTANA

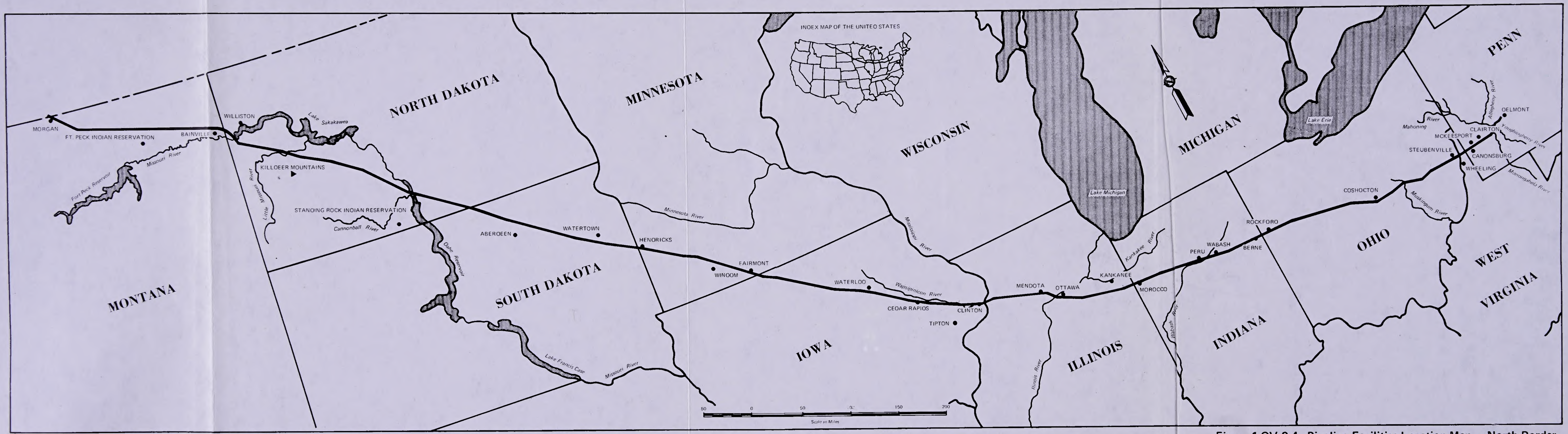
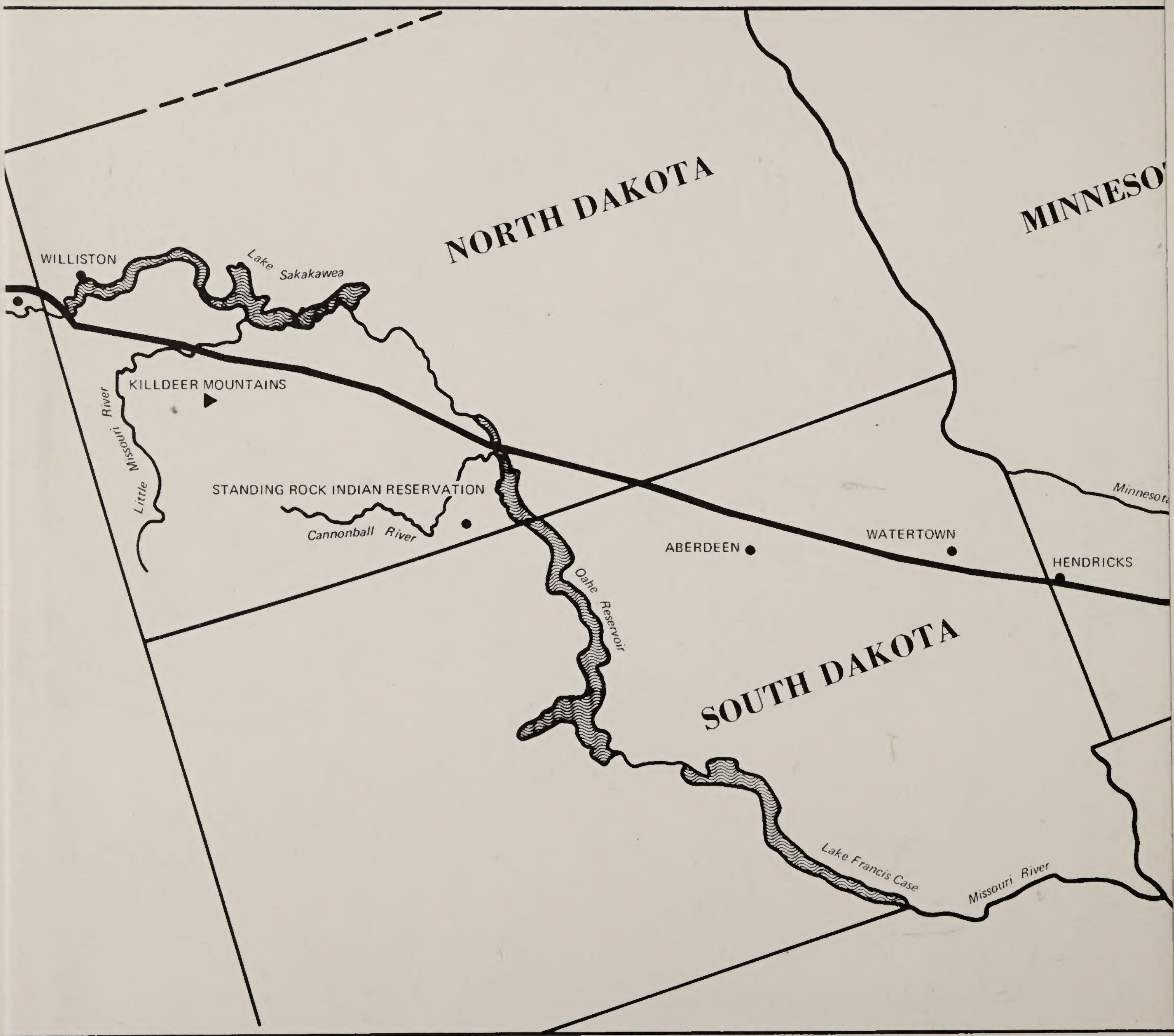


Figure 1.OV.2-4. Pipeline Facilities Location Map — North Border.



NORTH DAKOTA
MINNESO
WILLISTON
Lake Sakakawea
KILLDEER MOUNTAINS
Little Missouri River
STANDING ROCK INDIAN RESERVATION
Cannonball River
ABERDEEN
WATERTOWN
HENDRICKS
Minnesota
Oahe Reservoir
SOUTH DAKOTA
Lake Francis Case
Missouri River

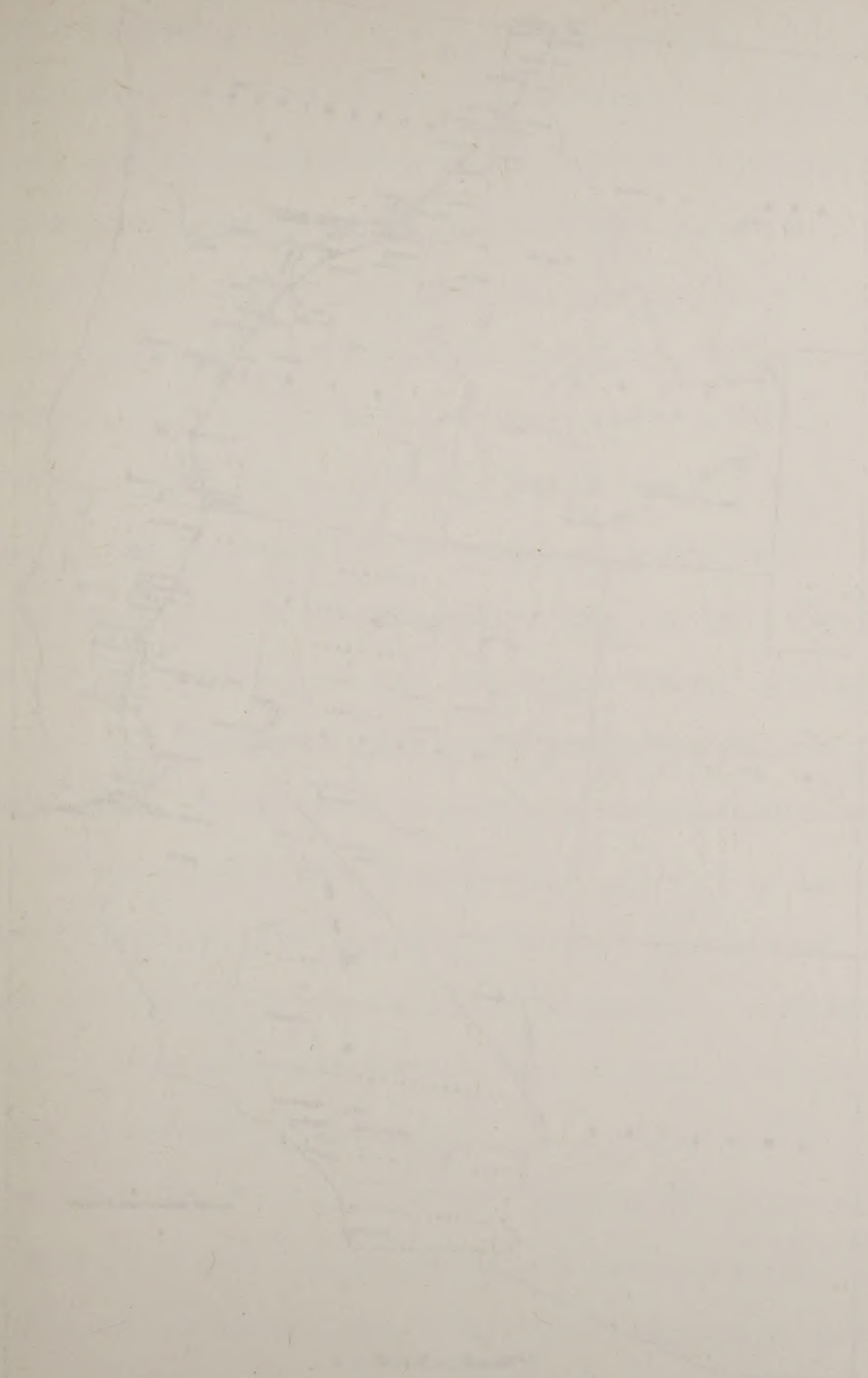


Figure I.OV.3 A. Pending Facilities Location Map — San Francisco

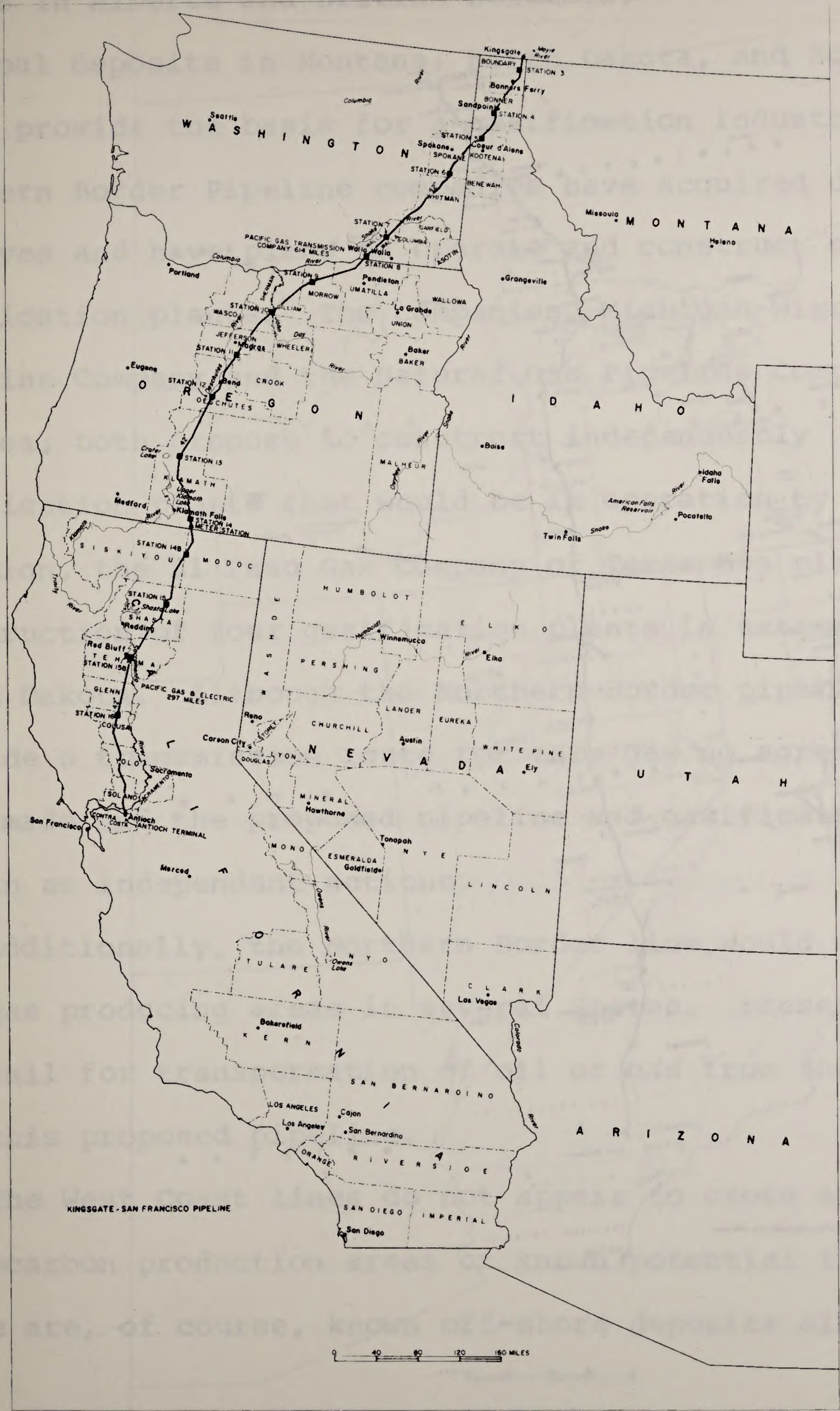


Figure 1.OV.2-5. Pipeline Facilities Location Map — San Francisco.

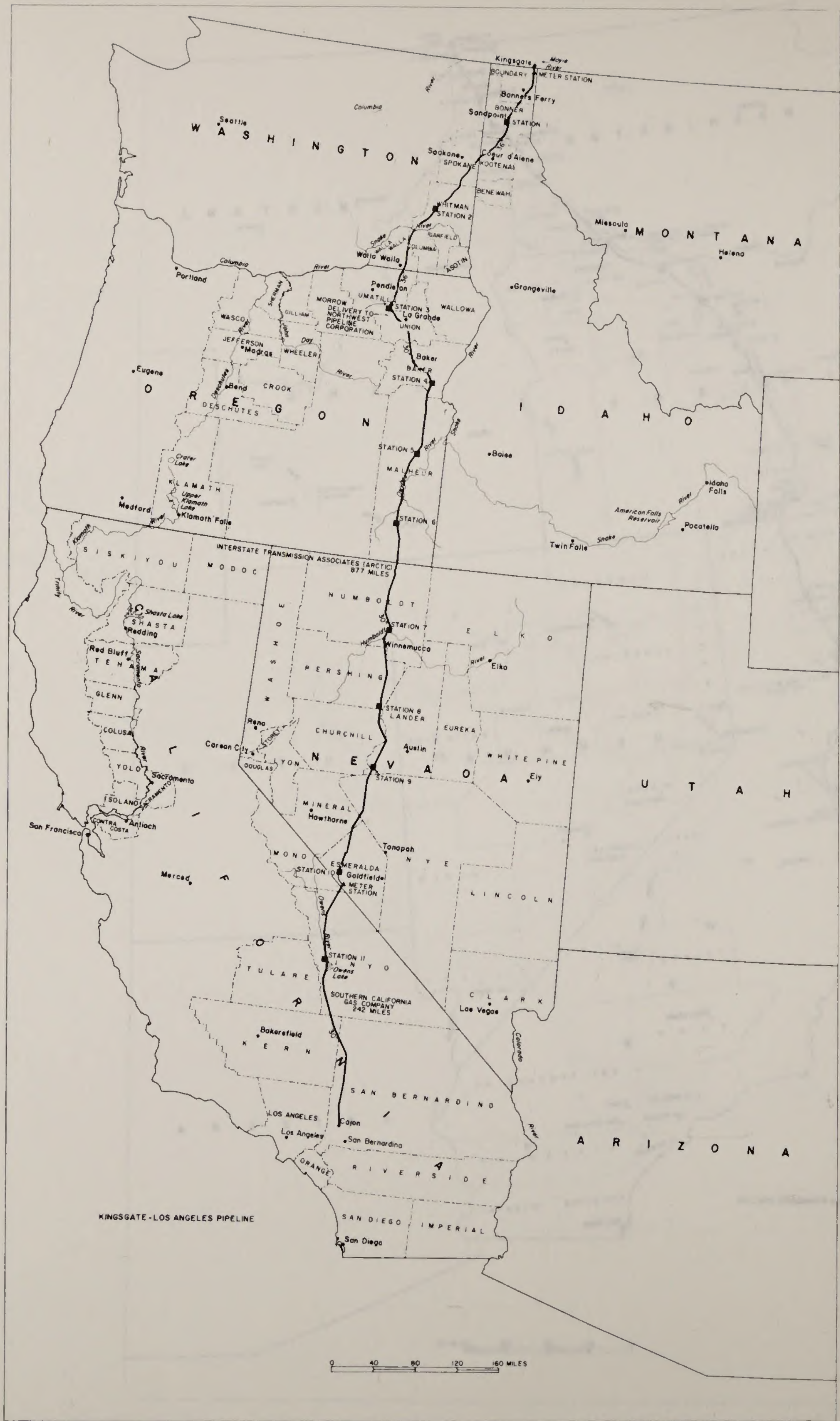


Figure 1.OV.2-6. Pipeline Facilities Location Map — Los Angeles.

with the added possibility of additions to the line from fields in Alberta and British Columbia.

Coal deposits in Montana, North Dakota, and South Dakota could provide the basis for a gasification industry. Two Northern Border Pipeline companies have acquired coal reserves and have plans to operate and construct coal gasification plants. The companies, Michigan-Wisconsin Pipeline Company and the Natural Gas Pipeline Company of America, both propose to construct independently gasification plants that would be in operation by 1980. In addition, the El Paso Gas Company of Texas has plans for construction of four gasification plants in extreme western North Dakota. Although the Northern Border pipeline could provide a transmission route for this gas no agreement has been made and the proposed pipeline and gasification plants remain as independent actions.

Additionally, the Northern Border line would cross oil and gas producing areas in several States. Present plans do not call for transportation of oil or gas from these fields via this proposed pipeline.

The West Coast lines do not appear to cross any major hydrocarbon production areas or known potential fields. There are, of course, known off-shore deposits along the

California coast. The Southern California Pipeline Company does receive some gas from both State and Federal offshore areas.

1.OV.3 Facilities

A. Pipeline Description

The companies have indicated that the pipe for all sections being constructed within the United States will meet the requirements of the American Petroleum Institute Specifications for High Test Line Pipe (API specification 5-LX), 19th edition. Except for the Kingsgate to San Francisco portion, the Applicants have specifically indicated that the pipe will also meet the American Petroleum Institute Specification for Spiral-Weld Line Pipe (API 5-LS), 7th edition. Based on a geotechnical evaluation of the pipeline application several questions relative to the integrity of the pipe were surfaced. To a large degree these questions relate to the effect of the low transmission temperature of the gas on the grade of pipe proposed to be used by the Applicants. The Applicants have on-going tests which may provide answers to these questions. The installed pipeline must be inspected for safety and approved by the Department of the Interior and the Department of Transportation, Office of Pipeline Safety, before gas transport begins. Table 1.OV.3-1 provides information on pipe diameter, wall thickness, yield strength, operating pressures, and total length in miles by pipe size.

Table 1.OV.3-1
Pipeline Data for Arctic Gas System

Applicant Company	Outside Diameter of Pipe Inches	Wall Thickness Inches	Minimum Yield Strength Pounds	Maximum Operating Pressure Pounds Per Square Inch	Grade[1]	Length of Pipeline Miles
Alaskan Arctic	48	.80	70,000	1680	X-70	195
Canadian Arctic	48	.72	70,000	1680		1740
	42	.63	70,000	1680		675
	30	.45	70,000	1680		15
Northern Border	48	.80	70,000	1680		1061
	42	.70	70,000	1680		77
	36	.60	70,000	1680		305
	26	.43	70,000	1680		176
Pacific Gas Trans.	42	[2]	[4]	[5]	X-65	618
Pacific Gas & Elect.	42	[2]	[4]	[5]	X-65	299
Interstate Trans.	36	[3]	65,000	1680	X-65	284
	30	[3]	65,000	1680	X-65	593
Southern Calif.	30	[3]	65,000	1680	X-65	242

[1]American Petroleum Institute.
[2]Pipe diameters vary from .93 inches to .56 inches.
[3]Pipe diameters for 36-inch pipe vary from .93 to .64 inches and for 30-inch pipe from .77 to .53 inches.
[4]Minimum yield strength varies from 65,000 to 77,000 pounds.
[5]Operating pressures on this segment of the line from north to south are given as follows: 472 miles at 1440 lbs.; 337 miles at 1250 lbs.; and 108 miles at 1040 lbs.

This will be a buried high pressure pipeline. The only above ground portions will be at compressor stations, certain crossings of streams, and cement drainage canals.

Title 49 of the Code of Federal Regulations provides that gas pipelines must be buried at least 18 inches with a maximum requirement of 36 inches subject to certain exceptions. The depths vary with class, location and soil conditions. Table 1.OV.3-2 appears in Subpart G, Section 192.327, Cover.

Table 1.OV.3-2

Pipeline Burial Depth Requirements

Location	Normal Soil	Consolidated Rock
Class 1	30	18
Class 2, 3, & 4	36	24
Drainage Ditches of Public Roads & Railroad Crossings	36	24

Most Applicants have indicated a minimum depth of burial of 30 inches, and that the pipe will be below scour depth at water crossings.

Class locations are covered in Section 192.5, Subpart A, Title 49 of the Code of Federal Regulations. The class

location unit is an area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline. The various unit classes are defined on the basis of the number of buildings intended for human occupancy. For example, Class 1 is defined as 10 or less buildings; the other end of the scale, Class 4 is defined as a unit with buildings of 4 or more stories being prevalent.

Since gas in a pipe flows toward lower pressure, the highest pressures will be recorded immediately downstream of the compressor stations. Unless some form of gas chiller is employed gas temperatures downstream from the compressor station will be higher.

Gas would be delivered to a metering station at Prudhoe Bay, Alaska and enter the pipeline at a temperature of 25° Fahrenheit and at 1,680 pounds of pressure. The gas will be maintained at this pressure throughout the line from Prudhoe Bay and through Canada. Until throughput in the line exceeds 2,250 million cubic feet per day no compressors will be required in Alaska. The first compressor station will be in Canada, approximately 224 miles from Prudhoe Bay, and will be equipped with propane refrigeration gas chillers. Gas will be maintained at 25° Fahrenheit to Travaillant Lake Junction; there temperatures will be reduced to the 12° F to

16° F range. The next four compressor stations beyond Milepost 670, near Fort Simpson, are not equipped with gas chilling equipment. In this area of approximately 230 miles the gas temperature would rise to about 70° Fahrenheit. Succeeding stations will be equipped with air exchange gas chillers and the gas will be at approximately 60° F at Caroline Junction.

Gas will be delivered to the Northern Border Pipeline Company at about 34° Fahrenheit and a gauge pressure of about 1,500 pounds. Initially, only one compressor station, at Milepost 758, will be operating, and gas will leave this station at a temperature of 100° F or more and at 1,300 p.s.i.g. (pounds per square inch gauge). When the line is in full operation gas flow temperatures will vary from 43° F to 80° F in summer and 33° to 58° in winter. The downstream pressure from most compressor stations will be 1,680 p.s.i.g.

Flow temperature of the gas in the Kingsgate to Antioch leg will range from 45° F in winter to 65° F in summer. Operating pressures along this line will vary from 1,440 p.s.i.g. for the initial 723 miles to 1,040 p.s.i.g. at the Antioch, California terminal. The other part of the West

Coast line to Cajon, California will operate at temperatures of 75° F to 100° F and a pressure of 1,600 p.s.i.g.

B. Descriptions and Operating Characteristics of Plants, Compressor Stations, and Related Facilities

Table 1.OV.1-1 in a preceding section summarizes the proposed facilities required for operation of the pipeline. No compressor facilities will be constructed along the line in Alaska until the volume of gas transported is increased beyond 2.25 Bcf (billion cubic feet) per day. Four maintenance sites will be selected and developed with certain initial facilities so that the sites can be used for compressor stations in the future. Each site will be a 15 acre pad of gravel placed over the undisturbed surface or on insulating materials. The purpose of the pad is to maintain the integrity of the permafrost.

Initial development will include the following facilities: liquid fuel storage, equipment storage, garage and repair facilities, living quarters, water storage, sewage treatment facilities, incinerator building, open

storage, in-line cleaning facilities, and generators for electricity. Primary communication facilities and a 2,400 foot airstrip with fuel will be constructed near each of the four maintenance sites.

In addition, one primary communication site will be developed at Prudhoe Bay and four repeater communication sites will be constructed at intermediate points between the maintenance sites. Each repeater site will be served with a helipad and an electric generator.

A material stockpile site will be developed at Camden Bay and another at Demarcation Bay. Facilities will include a wharf, material storage area, equipment storage area, a camp area, a fuel storage area, and related facilities. All material will be shipped by water and moved to the pipeline route over snow or ice roads. Both stockpile sites will also be served by a 2,400 foot airstrip.

Other facilities included nine block valve sites with helipads, the measurement station, a field operating headquarters at Prudhoe Bay, and approximately two miles of permanent roads. These roads will be 30 feet wide and serve the maintenance sites, connecting the maintenance sites with the primary communication sites and each of the six airstrips with the facility being served.

In Canada, 40 compressor stations will be built; those in the continuous permafrost zone which extends to Fort Simpson will be equipped with propane gas chillers. These sites will range between 15 and 25 acres. Typical associated facilities at the compressor sites are living quarters, garage, water storage, an incinerator building, fuel storage, chilling facilities, sanitary waste disposal facilities, and material storage. The actual foundation of these sites will depend on the individual site conditions. The applicant indicates several possibilities but reports the final design will depend on sub-soil investigation of the individual sites. See Chapter 1, Part III, for additional detail.

Other related facilities along the route in Canada include 21 airstrips, five being 6,000 feet long and the balance being 2,400 foot strips for short-take-off-and-landing aircraft. In addition, there would be 170 helipads located at the remote communication towers, block valves, and metering stations. Communication facilities will consist of more than 80 microwave towers built at compressor stations, measuring stations, and at intermediate line-of-sight points. All remote communication towers will include

a small building for an electric generator, and the site will be served by a helicopter.

Five gas measuring stations independent of the compressor stations would be constructed on fenced sites of 5 to 6 acres. The facilities would include a meter building and an instrument building. Two meter runs would be provided to provide continuous gas transmission in the event of a meter failure.

Block valves will be constructed at the compressor stations and at points approximately midway between compressor stations. The more remote valve sites will be served by helicopter.

Prior to and during the initial stages of construction, material must be stockpiled at sites along the pipeline. This is especially true of the northern portion of the route. To accomplish this, water transportation and overland transportation would be used. Temporary winter roads and trails would be used in the permafrost areas to interconnect facilities at compressor station sites. The trails would be for the use of tracked vehicles and would only involve clearing as necessary. A total of 18 wharves and stockpile sites will be built with appropriate overland

access to the pipeline and an additional nine stockpile sites will be established.

The Applicants propose road construction as shown in Table 1.OV.3-3.

Table 1.OV.3-3

Proposed Road Construction for Arctic Gas System

(Miles of Road by Class)

Line Segment	Permanent	Temporary	Trails	Total 1/
Alaska	2	250	Unk.	252
Canada	67	255	230	552
North Border	Unk.	50	0	50
San Francisco	Unk.	1	0	1
Los Angeles	20	Unk.	0	20
Total 1/	89	556	230	875

Unk. Information presently unknown

1/ Some totals incomplete

The Northern Border line would be developed with 30 compressor stations, and six additional sites for future development would be selected. Each station will require about 20 acres of land. Ancillary facilities will include

an equipment building, communication towers, in-line cleaning facilities, sanitary waste disposal, water supply, and material stockpile area. In-line cleaning facilities will also be constructed at each compressor station. These stations will be served by powerlines from nearby sources.

Eleven measuring delivery stations consisting of small buildings for control equipment, gas heating equipment to remove moisture, and piping for above-ground measuring will be required for a complete system. There will be three emergency stations as well. Each station will require a powerline and each will have a communication tower.

A total of 88 transmission-reception communication towers will be required for the Northern Border leg. Each compressor station and measuring station will be served by a tower. The balance of 41 towers would be located to assure reliable communication.

This system will also require the construction of 97 block valves. Thirty-six of the valves will be constructed at the compressor station sites; exact location of the other valves will not be determined until final design. Electrical power must be provided for each valve and a power line will be run from the nearest existing source to the site.

On the portion of the West Coast line from Kingsgate to San Francisco compressors will be added at four existing stations. In addition, modifications will be made on 13 units at nine of the existing stations.

The Los Angeles leg of the West Coast line will require 11 compressor stations to achieve maximum capacity. Facilities at each compressor station may include: buildings for operating controls, gas measuring equipment, on-site electric generating equipment, offices, and maintenance shops. Other facilities will be a waste disposal system, water supply, and roads.

Locations for operating bases have been identified. Additional facilities for which numbers and locations have not been provided are: mainline block valves at 15 to 20 mile intervals, landing strips up to 6,000 feet long, measurement stations, and communication towers.

Figures 1.OV.3-1 through 1.OV.3-5 provide diagrams and sketches typical of the facilities described above.

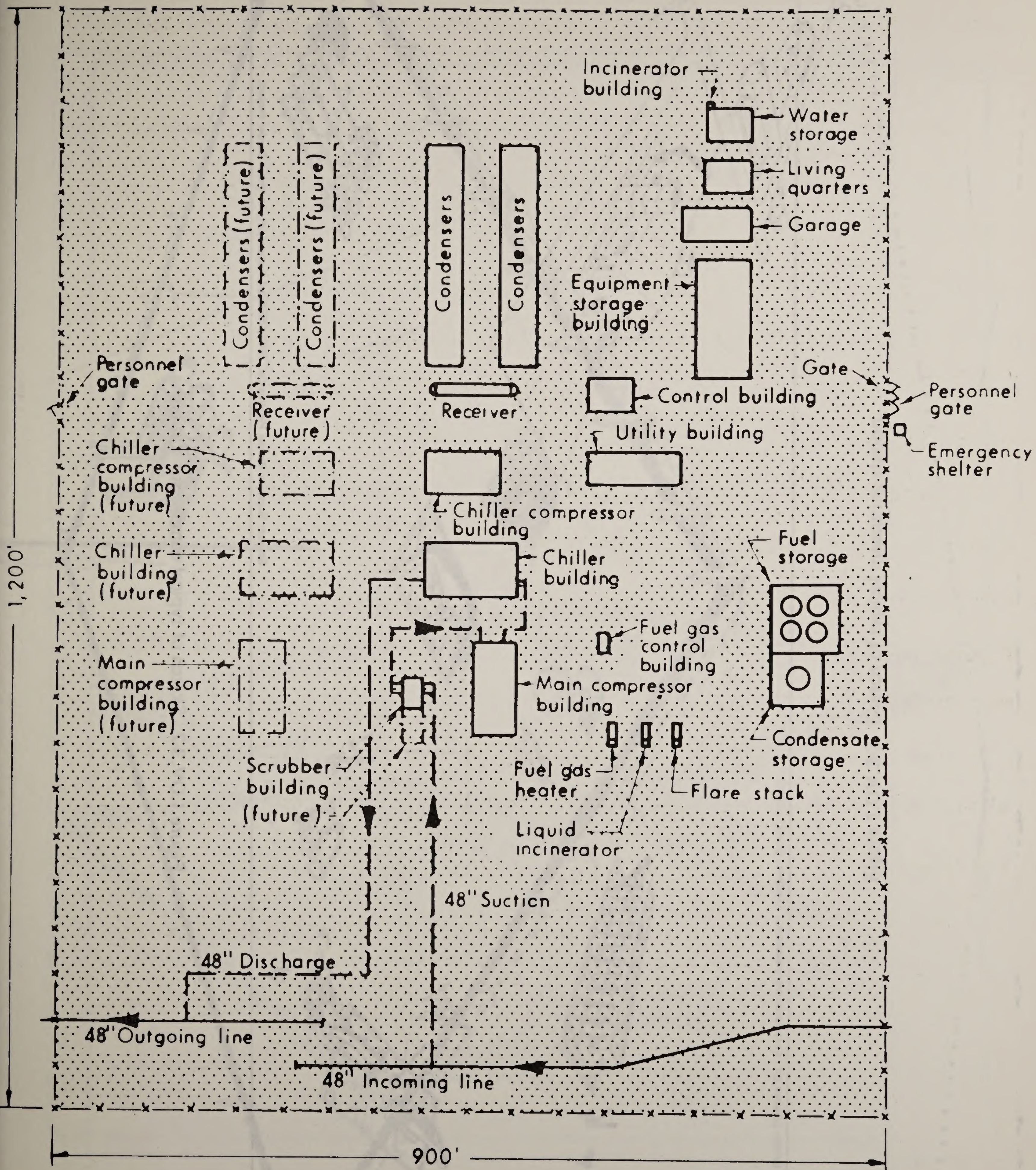
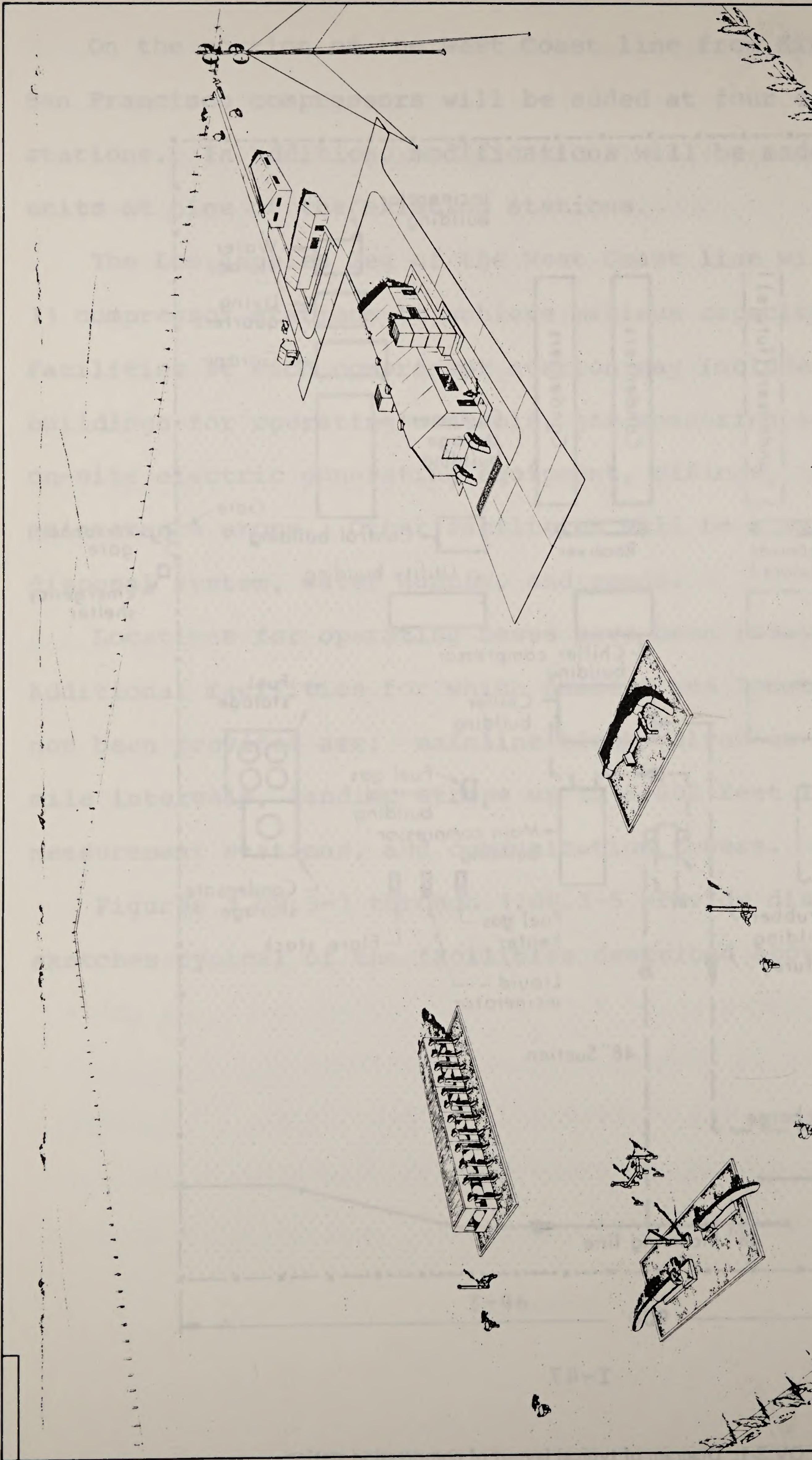


Figure 1.OV.3-1. Diagram of typical layout of compression station.

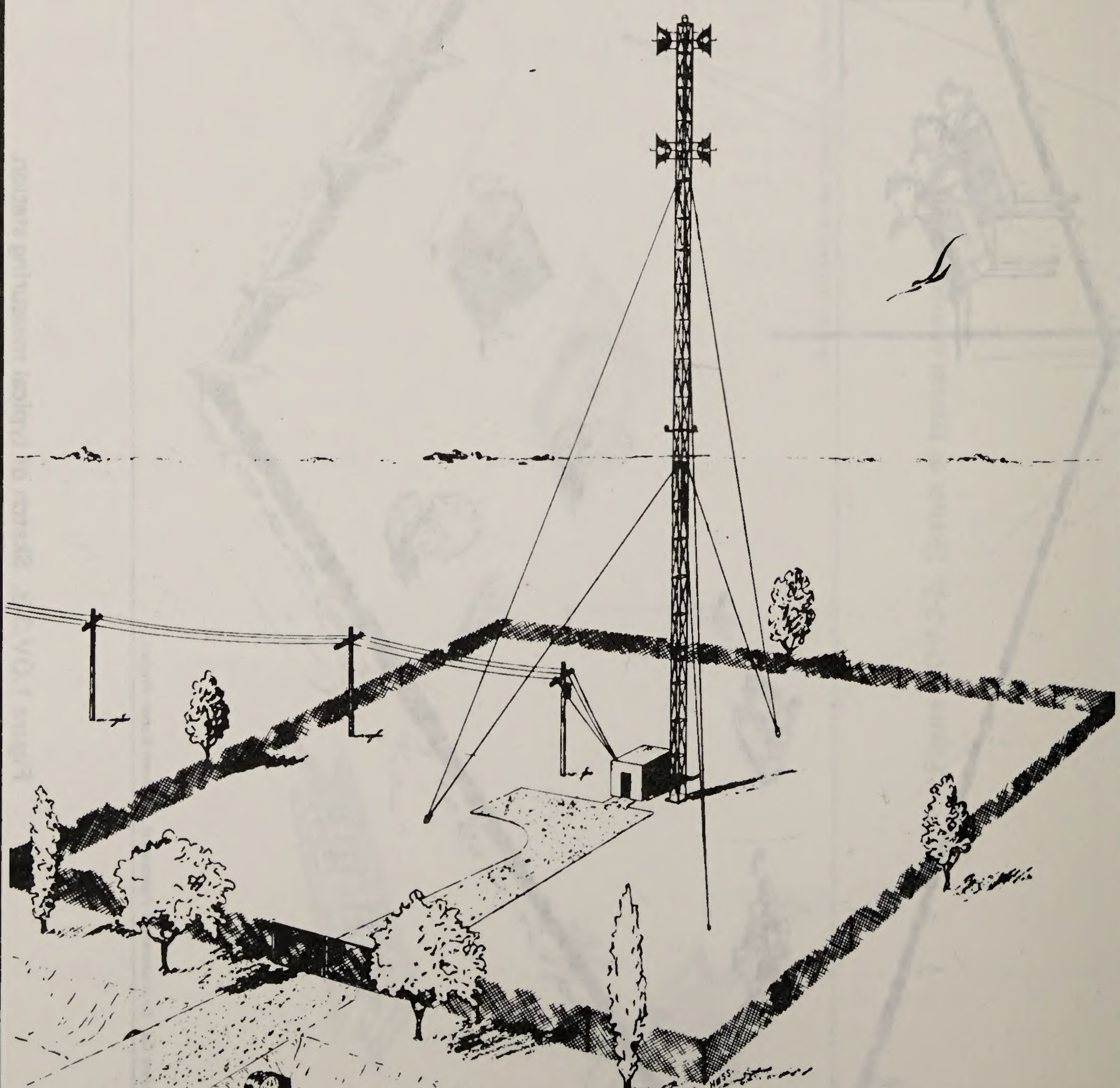


Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.3-2. Sketch of typical compressor station.

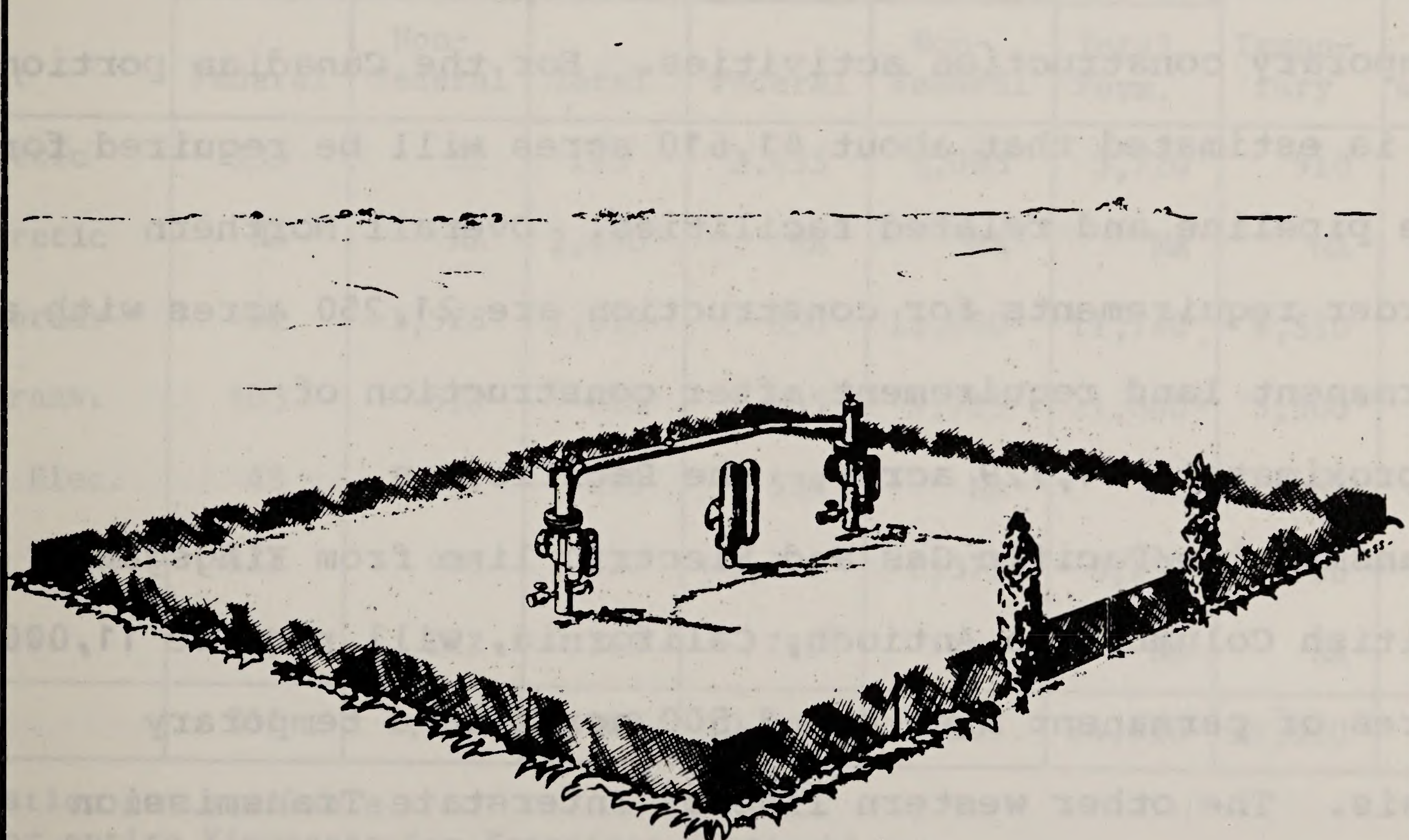
Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.3-3. Sketch of typical measuring station.



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.3-4. Sketch of typical communication tower.



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.3-5. Sketch of typical block valve.

1.OV.4 Land Requirements

A. Right-of-Way

Although right-of-way locations are not finalized, estimates of acreage required for rights-of-way, related facilities, and temporary areas required for construction activities have been developed. The initial projected requirement for the 195 mile section in Alaska is 4,630 acres overall. Approximately 3,720 acres will be permanently committed and about 910 acres will be for temporary construction activities. For the Canadian portion it is estimated that about 41,610 acres will be required for the pipeline and related facilities. Overall Northern Border requirements for construction are 21,250 acres with a permanent land requirement after construction of approximately 11,729 acres. The Pacific Gas Transmission/Pacific Gas and Electric line from Kingsgate, British Columbia to Antioch, California, will require 11,000 acres of permanent area and 3,500 acres on a temporary basis. The other western line of Interstate Transmission Associates (Arctic) and Southern California Gas requires an estimated 14,000 acres of land during the construction phase; about 8,150 acres would be classed in the permanent category. Table 1.OV.4-1 shows overall right-of-way

Table 1.OV.4-1
Overall Land Requirements

Segment	Right-of-Way Length--Miles			Land Requirements - Acres				
				Permanent			Temporary	Total Land Permanent and Temporary
	Federal	Non-Federal	Total	Federal	Non-Federal	Total Perm.		
Alaskan Arctic	133	62	195	2,635	1,085	3,720	910	4,630
Canadian Arctic	NA	NA	2,430[4]	NA	NA	NA	NA	41,610[4]
Northern Border	91	1,528	1,619	650	11,090	11,740	9,510	21,250
Pac. Gas Trans.	103	515	618	1,285[1]	9,715[1]	11,000[1]	3,500[1]	14,500[1]
Pac. Gas & Elec.	48	251	299	530[3]	NA	NA	NA	NA
Interstate Trans.	471	406	877	5,775[2]	2,375[2]	8,150[2]	5,900[2]	14,050[2]
Southern Cal.	120	122	242	725[3]	NA	NA	NA	NA
Total	967	2,883	6,280	10,345	24,265	34,610	19,820	96,040

NA- Information not available
[1]Data is for entire Kingsgate-San Francisco (Antioch) Leg
[2]Data is for entire Kingsgate-Los Angeles (Cajon) Leg
[3]Figures not included in Totals
[4]Only gross totals available for Canada

lengths, permanent and temporary acreage, and Federal and non-Federal land requirements for applicant companies.

In Alaska there is no existing right-of-way along the North Slope towards the Mackenzie Delta Region. From maps it would appear that portions of the Canadian Arctic Gas Pipeline Company route in Alberta follows existing rights-of-way. The Applicant, however, does not address the use of existing rights-of-way.

The Northern Border Pipeline Company indicates that their line "adjoins or abuts 23.6 miles of existing rights-of-way". On the West Coast lines there will be considerable use of existing rights-of-way or use of a parallel right-of-way. The San Francisco and Los Angeles legs of the West Coast line will be parallel for the first 206 miles in the United States. The Los Angeles leg will utilize 267 miles of existing rights-of-way.

B. Plant, Station, and Related Facility Site Acreage

Acreages required for some facilities have not been specifically identified and in many cases a range of acreage is provided. Furthermore, some facilities will be built at

existing sites, particularly on the West Coast line, so that little additional acreage will be required.

Based on the information provided the following facility acreage requirements for selected facilities are shown in Table 1.OV.4-2.

Table 1.OV.4-2

Estimated Acreage Requirements for

Selected Facilities

	Maximum	Minumum
Compressor Stations	1,660	1,260
Air Fields	1,860	430
Helipads	1,470	1,470
Block Valves	15	10
Communication Sites	360 1/	20
Totals	5,365 Acres	3,190 Acres

1/ Northern Border estimates 4 acres per site which is 40 times larger than the next highest estimate.

In addition, there would be temporary commitments of acreage for stream crossings, roads, staging areas and similar activities of short duration.

C. Related Land Areas Affected

Except in Alaska, where the only roads are the North Slope haul road and private roads within the Prudhoe Bay oil and gas fields, existing roads will be used as much as possible. During construction, traffic on certain segments will be increased. In all parts of the system in the United States the Applicants indicate no displacement of existing housing. Refer to individual Parts II, III, IV, and V for complete discussion.

1.OV.5 Schedule

A. Duration and Phasing of Project Construction

Most companies propose to start construction approximately 1 year after approvals are received. Depending on the time of the year that approval was granted certain preliminary work, such as surveying and clearing, might be undertaken immediately. In other cases weather conditions could delay the start of construction by nearly one year. Figure 1.OV.5-1 contains a graphic protrayal of the proposed construction periods on each segment.

The construction of the gas pipeline in Alaska, including the related facilities, will be phased over a three year period beginning the first summer after project approval. Most construction work will occur during the winter months, from November to April, and snow roads will be used to provide access throughout the pipeline construction area. If snow roads cannot be constructed, ice roads will be developed using trucks to spray water to form successive coatings of ice. The actual installation of the pipe will be accomplished in the third winter construction season.

In Canada the construction of the pipeline, related facilities, and the Richards Island supply line would be

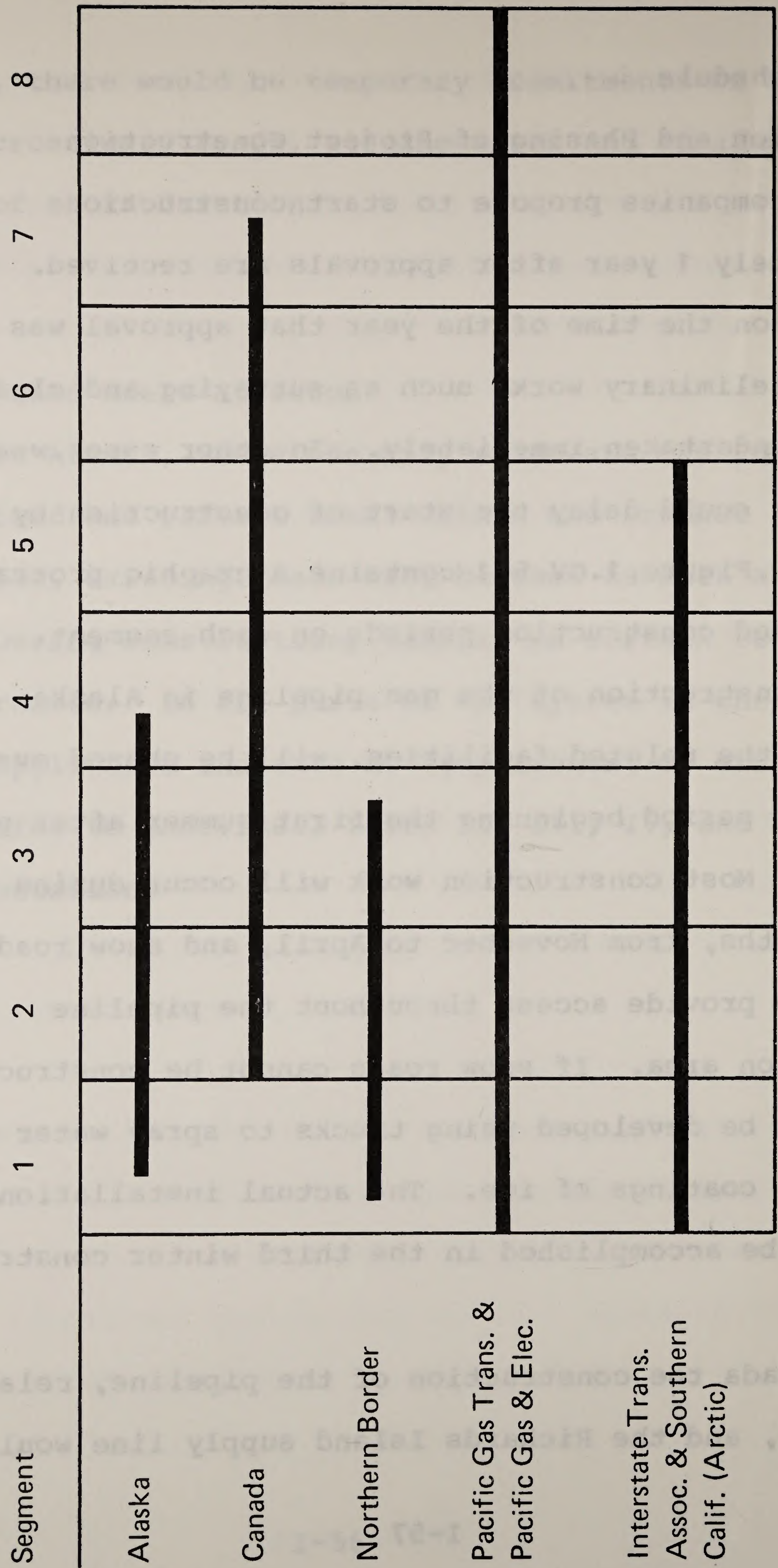


Figure 1.OV.5-1. Proposed construction periods.

completed in the seventh construction year. Actual pipeline construction would begin late in the second year and be completed in the fifth year. Preparatory work such as stockpiling, surveying, and site preparation would be accomplished prior to that. Compressor station construction would be accomplished between the third and seventh year.

All pipeline installation north of Caroline Junction would be accomplished in the winter. Based on the construction schedule, gas would start up in the lines from the Mackenzie Delta field to Kingsgate and Monchy towards the end of the third year. The Prudhoe Bay field would come on line one year later and the system capability would be 2.25 Bcf (billion cubic feet) per day. Continued construction of compressor stations into the seventh year would bring the Alaska-Canada system to the 4.5 Bcf per day capacity.

The Northern Border portion of the line will be constructed in two phases in approximately 25 months. No winter construction is contemplated and most work will be accomplished between May and November. It is anticipated that the construction will be curtailed during March and April because of vehicle weight restrictions imposed on roads in this area during the spring season.

During the first phase of 16 months, approximately 1,100 miles of pipe will be installed from the Canadian border to Kankakee, Illinois. One compressor station, three measuring stations, and seven of the twelve major river crossings will also be completed. Phase 2, lasting nine months, calls for completion of the pipe laying, five major river crossings, construction of 29 compressor stations, 88 communication towers, and eleven delivery measuring stations.

An eight year period will be required to complete the line from Kingsgate to Antioch, California. Construction would commence one year after approval is received.

The Kingsgate to Cajon, California leg would be constructed in phases over a five year period. Phase 1 of the Interstate Transmission Associates (Arctic) construction would require approximately 12 months, and Southern California Pipeline Company estimates 6 months to complete their Phase 1. Delivery of gas is expected to begin following completion and testing of facilities constructed during Phase I. The volumes of gas transported are expected to increase with each successive construction phase until the fifth year.

Due to the uncertainty of when the necessary approvals, permits, and authorizations will be granted, most companies

indicate that construction will begin one year after approval. The time of the year that approval is given can affect the proposed schedules since some companies propose only winter construction and others indicate no winter construction. Construction will be conducted concurrently on all lines with the longest projected completion period being 8 years for the San Francisco leg.

The Canadian Arctic Gas Pipeline Company indicates that work would commence in a summer season and that during the fourth year they would be ready to accept gas from Prudhoe Bay. Their total pipeline construction would not be completed until the seventh year. Timing of the approval of the Canadian segment is therefore critical to any overall projection of delivery.

B. Individual Facility Construction Time

C. Time Required for Preparatory Functions

The time required to construct individual facilities will vary from Applicant to Applicant. Construction time is dependent on a variety of factors including availability of skills, availability of material, accessibility of the site, conditions at the site, and weather. Preparatory work such

as road construction, clearing, grading, and surveying also varies as to time required. In most cases the Applicants have scheduled these operations into their construction procedures.

D. Maintenance of Public Services During Construction

There are no public service facilities along the proposed pipeline route in Alaska. This matter is not covered in the material describing the Canadian portion of the route although highway, railroad, and crossings of other utility lines are apparent along the southern portion of the route.

The treatment along the routes of all proposed lines in the lower 48 States is generally uniform. When the pipeline intersects a highway the method of crossing will depend generally on the class of the road and specifically on jurisdictional requirements. Some local roads with only limited traffic may well be crossed by open cut methods, that is, the traditional open ditching, laying of the pipe and covering.

Interstate highways and other heavily traveled roads that can tolerate only limited interruption of the traffic

flow will undoubtedly be crossed by tunneling or boring. In these cases a tunnel will be bored under the highway at sufficient depth to protect the highway. The pipeline will then be run under the highway within a casing pipe or a larger transmission pipe to protect the gas line from unusual external pressure. This type of installation requires that the outer casing be vented to the atmosphere. Generally, railroads will be crossed by the tunneling technique.

Any underground utilities such as other pipelines, telephone lines, water and sewer lines will be located in advance of the trenching operation and marked. These intersections will be carefully excavated and the pipe will be installed over or under the existing utility and separated from it by means of fill or artificial support. This same technique will be used in those agricultural areas where drainage tiles are frequently encountered. In certain cases where concrete lined canals or water courses are encountered it may be necessary to run a short section of the line overhead rather than tunneling beneath the utility.

E. Schedule of Currently Proposed Future Construction

The Applicants who indicate the possibility of additional future construction, such as the 4 compressor stations and gas chillers in Alaska and 6 future compressors on the Northern Border line, state that such construction is contingent on the transportation of increased volumes of gas. In Alaska this means a volume in excess of 2.25 billion cubic feet per day and for the Northern Border more than 3.5 billion cubic feet per day.

1.OV.6 Construction Procedures

A. Preparatory Procedures

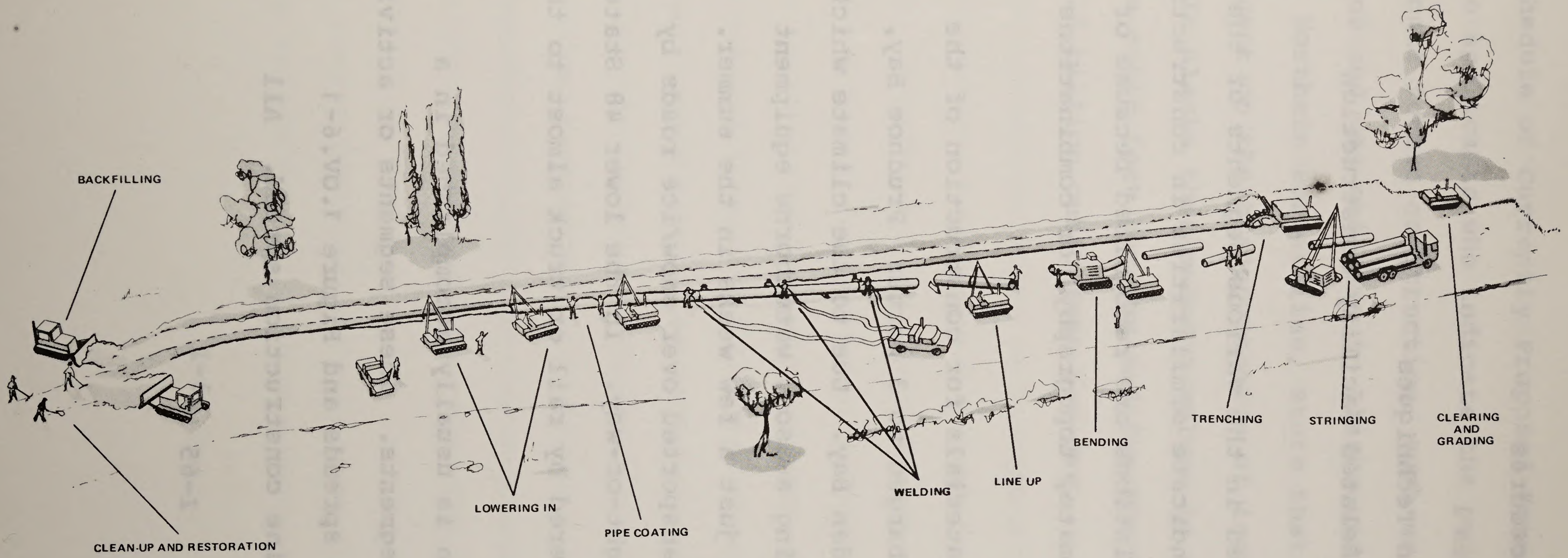
B. Pipeline Construction Techniques

C. Plant, Station, and Related Facility Construction Techniques

All companies involved in the various segments of the total pipeline project indicate similarities in construction procedures. Certain variations are recognized because of geographic location, climate, topography, or combinations of these factors.

The pipe and other materials for construction of the Alaskan segment will be barged to 3 ports: Prudhoe Bay, Demarcation Bay, and Camden Bay. Due to the climate which results in a short shipping season, waterborne equipment must be delivered during just a few weeks in the summer. From there it will be transported over snow/ice roads by truck to the proposed right-of-way. In the lower 48 States, coated pipe can be delivered by rail or truck almost to the right-of-way.

Pipeline construction is usually accomplished in a series of simultaneous segments. These segments or activity units are referred to as spreads and Figure 1.OV.6-1 presents a typical pipeline construction spread. All



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

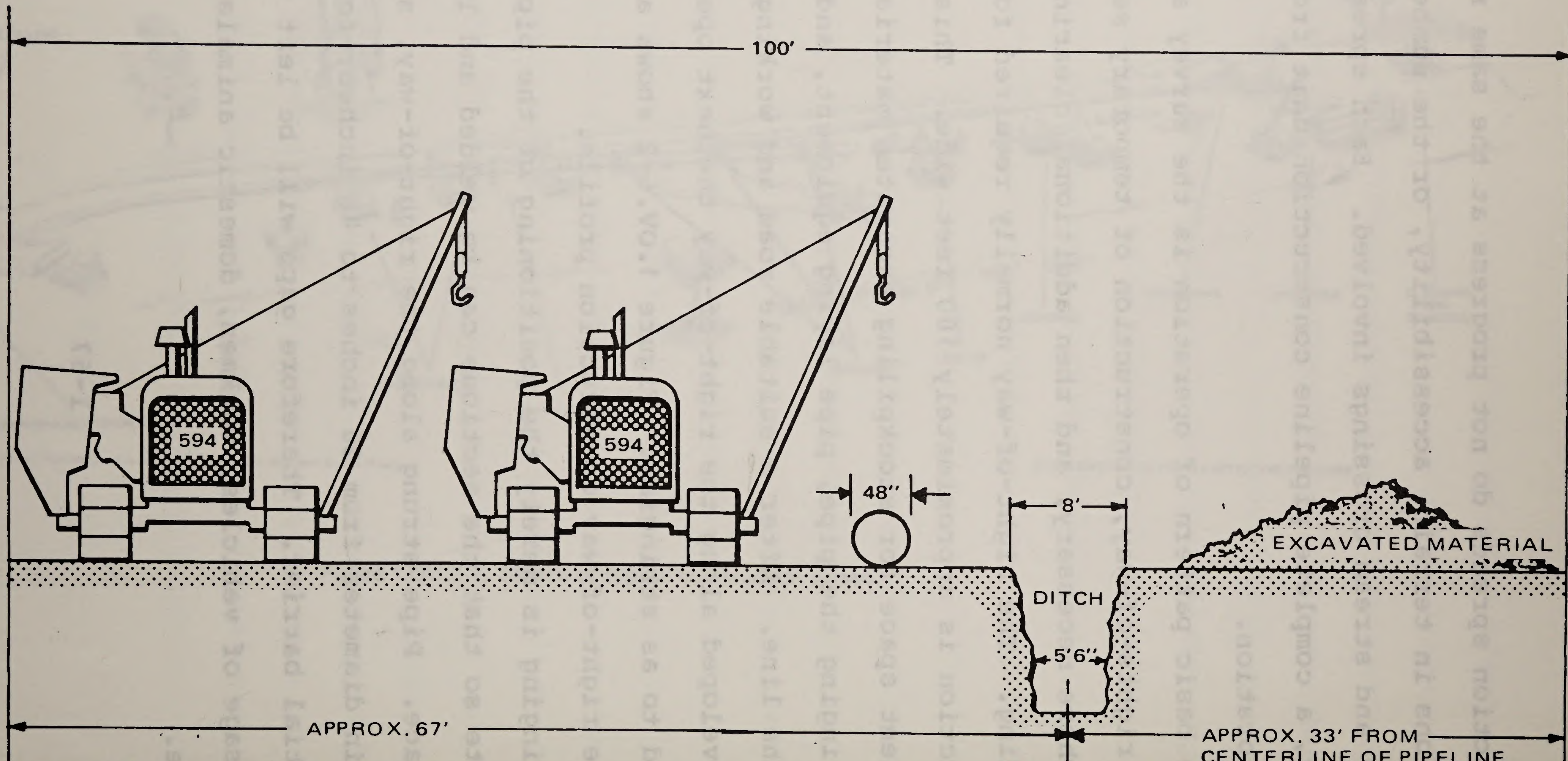
SCALE CONDENSED FOR ILLUSTRATIVE PURPOSES

Figure 1.OV.6-1. Sketch of typical construction spread.

construction spreads do not progress at the same rate due to variations in terrain, accessibility, or the number of utility and stream crossings involved. Each spread is, however, a complete pipeline construction unit from clearing to restoration.

The basic pattern of operation is the survey and staking of the rights-of-way, construction of temporary service roads where necessary, and then additional clearing followed by grading. The right-of-way normally required for construction is approximately 100 feet wide. This permits sufficient space for stockpiling excavated material, room for stringing the pipe, pipe laying equipment, and travel along the line. After a suitable road and working area has been developed along the right-of-way the next operation is referred to as stringing. Figure 1.OV.6-2 shows a typical pipeline right-of-way construction profile.

Stringing is merely the positioning of the pipe along the route so that the sections can be welded and lowered into place. Pipe strung along the right-of-way, since it ranges in diameter from 26 inches to 48 inches, forms a substantial barrier. Therefore gaps will be left to permit the passage of vehicles, workmen, domestic animals, and wildlife.



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-2. Sketch of typical construction profile.

The next operation is normally trenching or ditching. This is the excavation for the underground installation of the pipe. These trenches are usually dug to provide a minimum of one foot of clearance on each side of the pipe and to sufficient depth to provide 24 inches to 60 inches of cover. The depth of cover depends on several factors such as soil conditions, safety factors, and any specific requirements imposed by a responsible agency such as the Department of Transportation. The base of the trench must be smooth and in rocky areas a layer of sand or similar material might be used as a base or bedding for the pipe.

Trenching is accomplished by means of mechanical ditching machines. These machines can be wheel mounted self-propelled, tractor drawn, or single toothed rippers; in some cases backhoes are used. In those areas where rock is encountered it may be necessary to use explosives and blast the trench. Where blasting is necessary precautions will include notifying adjacent land owners, posting flagmen, and using mats to minimize flying debris.

Bending, welding, coating, and wrapping are the next operations preparatory to lowering the pipe. Since the pipe is delivered in straight lengths, minor variations in alignment are accomplished by bending. The bending is

accomplished by use of a track-mounted hydraulically operated machine.

Welding is performed in the field and can be accomplished manually or with automatic equipment. Welding procedures will be established prior to construction. Regardless of the system, welds will be subjected to visual and mechanical inspection techniques. The latter involves radiographic and ultrasonic sensors to detect skips or incomplete welds. Subpart E, "Welding of Steel in Pipelines," Code of Federal Regulations 49, Part 192, sets forth requirements for establishing welding procedures, qualification of welders, and inspection of welds.

Coating and wrapping are applied for the protection of the pipe. The coating is part of the corrosion control and the wrapping is to provide surface protection from rocks and frozen soil. Coating can be factory applied or field coating can be employed. There are several systems or types and the method or type used is dependent on several factors, including soil corrosiveness, water content, and coating technology. The various possibilities for coating and wrapping the pipe are asphalt and asphalt-saturated paper, somastic (asphalt and sand mixture), coal tar with coal tar saturated paper, butyl tape or thin film epoxy.

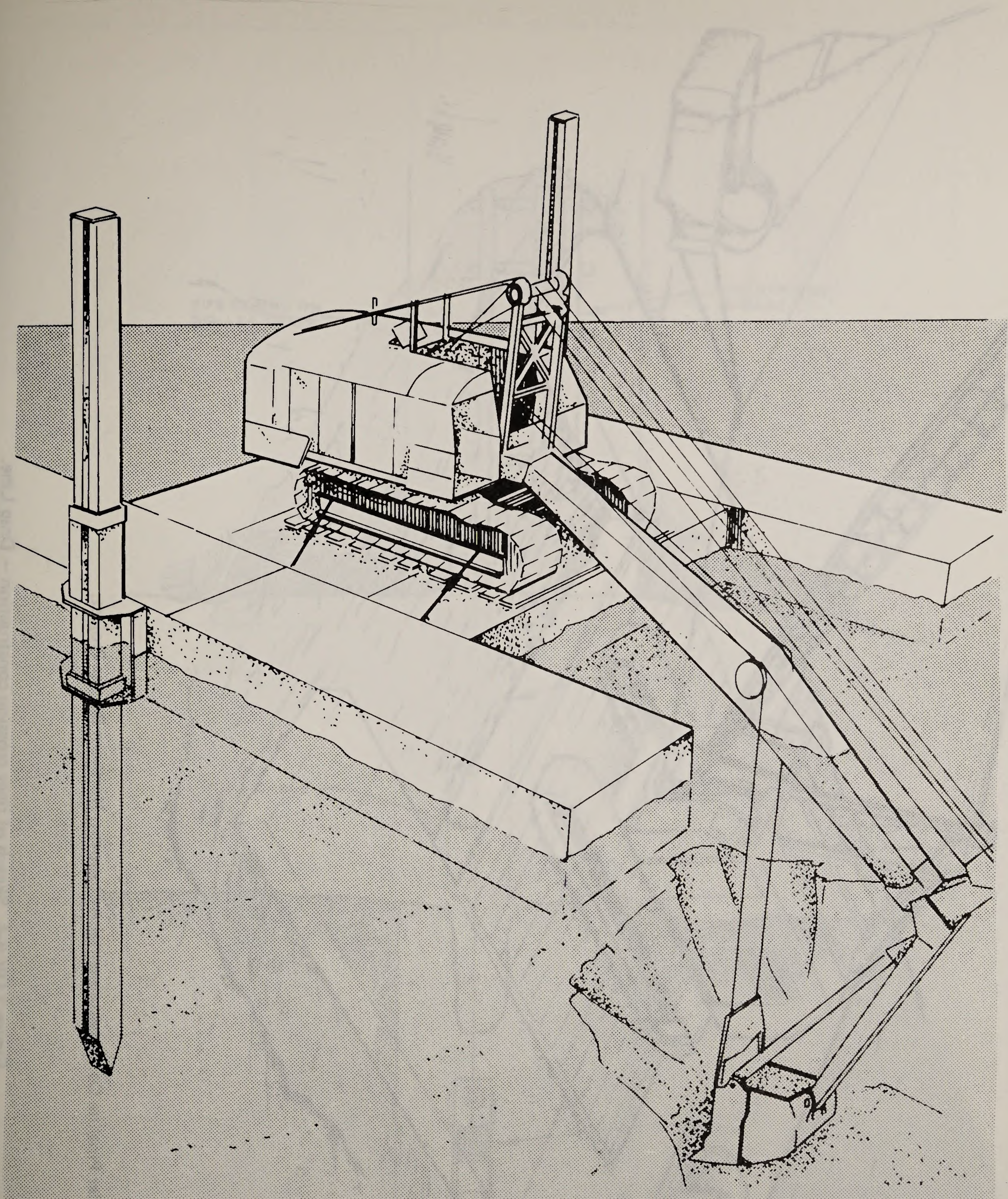
The lowering-in operation is normally performed as an integral step in the wrapping and coating sequence. Most commonly side-boom crawler tractors are used to lower the pipe into the trench. If the pipe cannot be lowered immediately, it is placed on supports along the trench that will protect the coating until the pipe can be lowered in.

Several modifications of technique are followed in trenching and lowering-in across rivers. Smaller streams may be trenched by use of draglines on shore; on larger rivers it may be necessary to use barges to float the excavation equipment. Installation of the pipe can be accomplished by what is known as the "bottom pull" method or by variations using floating equipment. In the bottom pull method pipe is welded on one side of the river and pulled through the trench to the other side by use of a crawler tractor. Figures 1.OV.6-3 and 1.OV.6-4 illustrate two trenching methods with floating equipment.

A barge is sometimes used on large rivers as the operations base, carrying both pipe and welders. As the pipe is welded, it is fed off a ramp into the trench. A technique used on smaller rivers is the floating bridge method. This involves welding pipe on shore into a length equal to the width of the stream. Then the pipe is floated

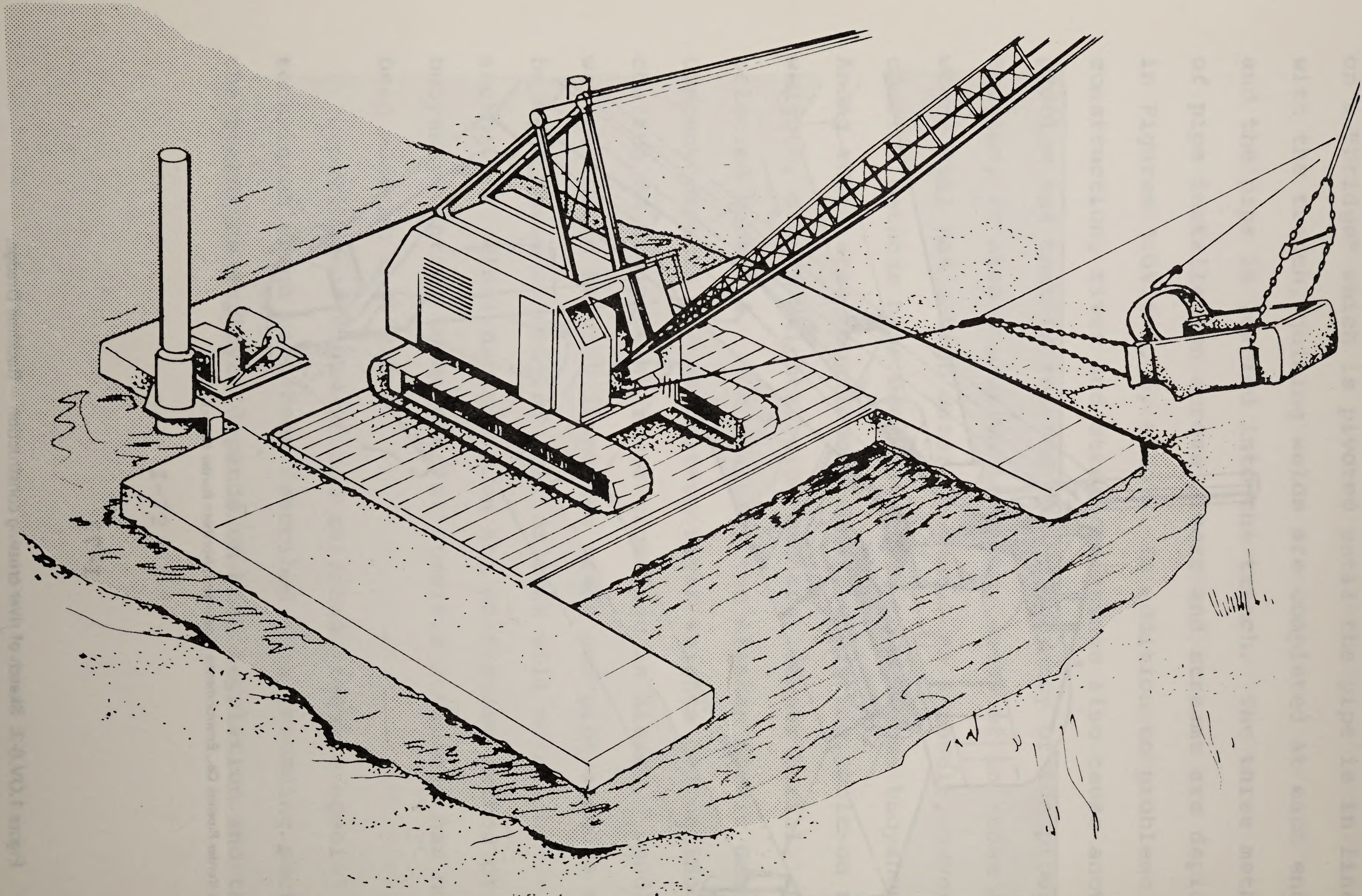
on a "bridge" which is pivoted until the pipe is in line with the trench, joining welds are completed at each end, and the pipe is lowered into the trench. The three methods of pipe installation across rivers and streams are depicted in Figures 1.OV.6-5, 6, and 7. In addition to problems of construction, river and stream crossings also cause another problem and that is related to the buoyancy of the pipe. Buoyancy is also a problem in marshy areas or in those areas where soil has a high water content. As a result, several control methods have been developed to overcome buoyancy. Among these are: continuous concrete coating, bolt-on river weights, saddle weights, pipe anchors, deeper burial, and selected backfill. For example, the Alaskan Arctic Gas Company expects to use bolt-on river weights or continuous coating on the pipe at river crossings in Alaska. Saddle weights would be used in muskeg areas and pipe anchors might be used where underlying soil or rock will maintain anchorage. Final decisions on the particular method of buoyancy control to be used at specific locations has not been made at this time.

Crossings of highways and railroads require special techniques which have been described in a preceding section; the technique employed depends on both regulation and the



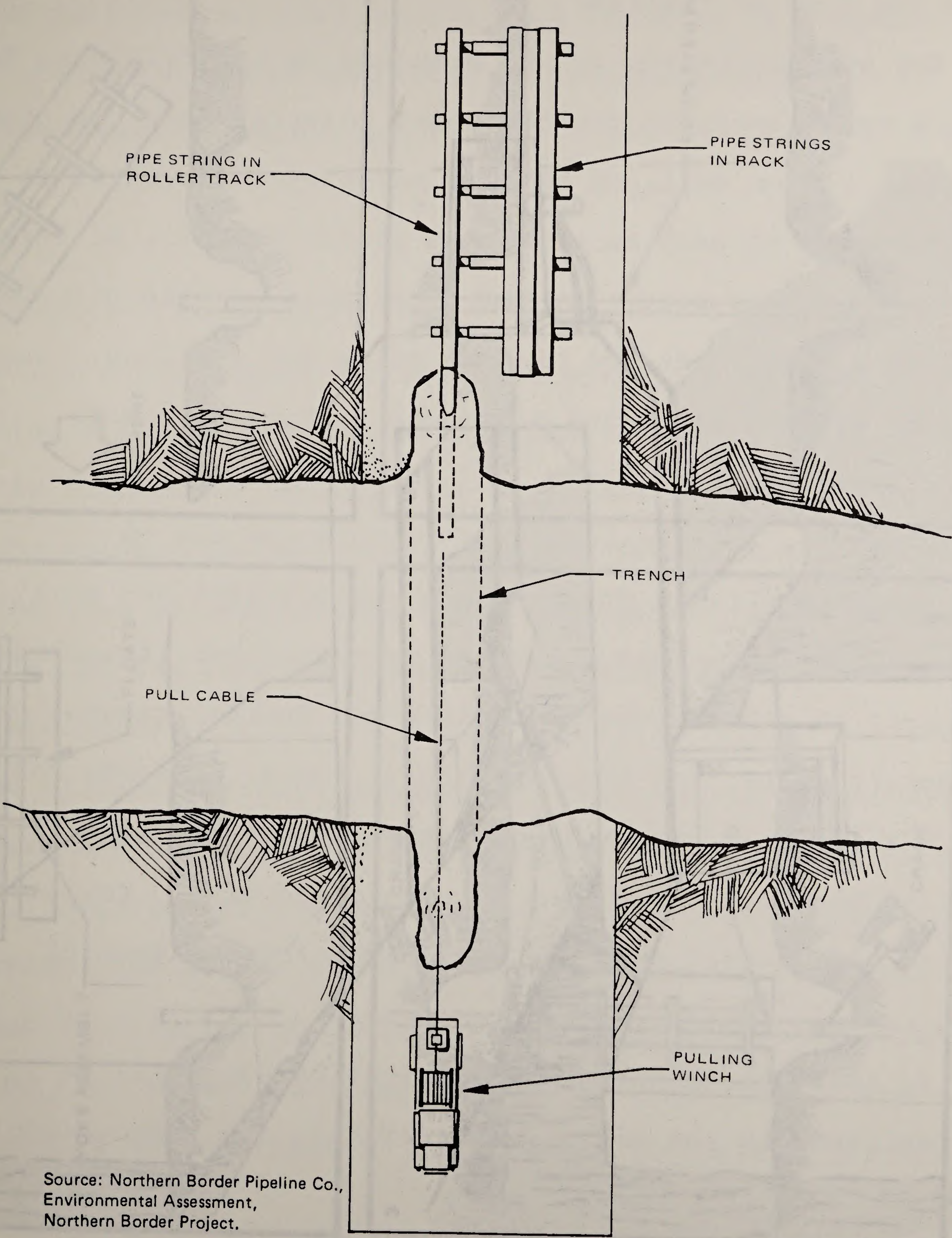
Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-3. Sketch of river crossing construction – Backhoe Dredge.



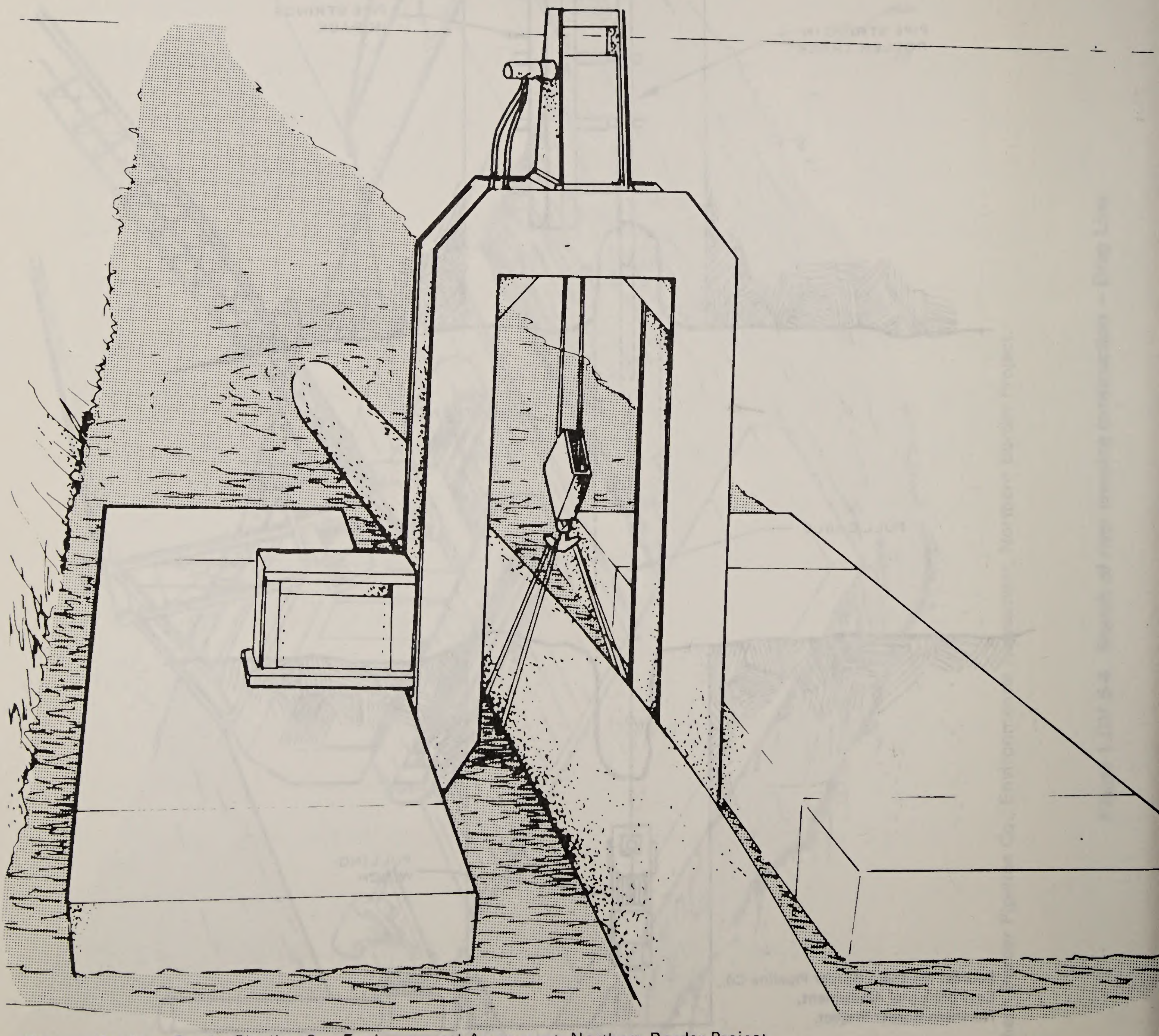
Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-4. Sketch of river crossing construction — Drag Line.



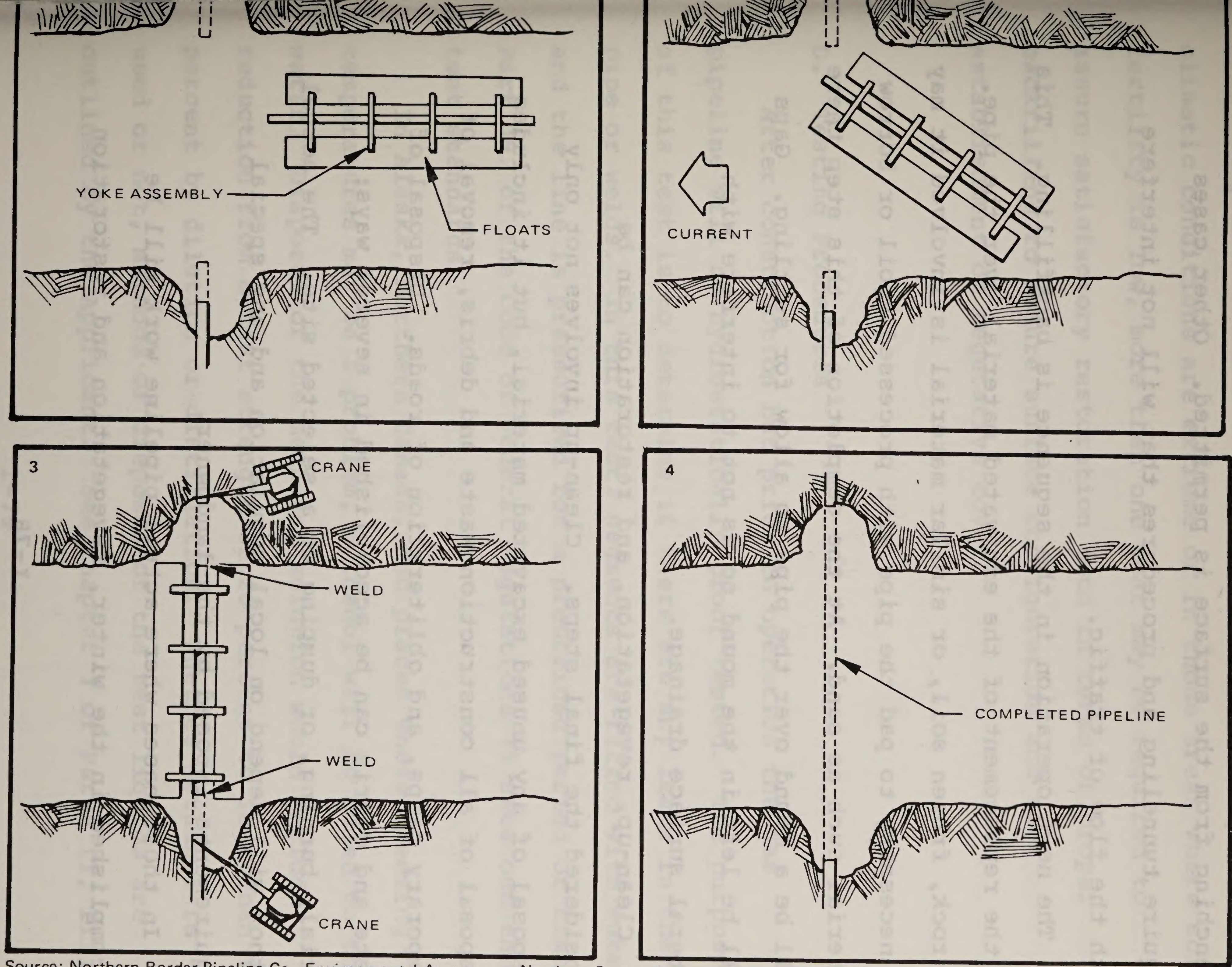
Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-5. Sketch of bottom pull method of river crossing.



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-6. Sketch of floating bridge with yoke assembly for river crossing.



Source: Northern Border Pipeline Co., Environmental Assessment, Northern Border Project.

Figure 1.OV.6-7. Diagrammatic of floating bridge river crossing.

permissibility of interrupting traffic. In some cases trenching from the surface is permitted. Other cases require tunneling and procedures that will not interfere with the flow of traffic.

The next operation in the sequence is backfilling. This is the replacement of the excavated material over the pipe. If rock, frozen soil, or similar material is involved it may be necessary to pad the pipe with processed spoil or borrow material such as sand. At the completion of this step there will be a mound over the pipe to allow for settling. Gaps will be left in the mound so as not to interfere with lateral surface drainage.

Clean-up, revegetation, and restoration can be considered the final steps. Clean-up involves not only disposal of any unused excavated material, but it includes disposal of all construction waste and debris, removal of temporary camps, and obliteration of roads. Disposal of waste and debris can be accomplished in several ways: burial, burning, or dumping at a selected site. The actual method will depend on local regulation and any special requirements imposed by the landowner.

In those cases where actual pipeline work will be accomplished in the winter, revegetation and restoration

will carry over into the following summer. Where the climatic conditions are extreme or in those areas where soil fertility is low, more than one year may be required to assure satisfactory restoration both in terms of proper backfilling to assure surface configuration and re-establishment of vegetative cover.

D. Testing Procedures

After construction but prior to operation the gas pipeline will be hydrostatically proof tested. The purpose of this test is to determine if there are any leaks in the pipe or welds. In this test, segments are filled with water and the line is pressurized for a prescribed period of time. Part 192 of the Code of Federal Regulations 49 sets out the test standards.

In Alaska, northern Canada, and places where freezing temperatures may be a problem, methanol will be added to the water. Disposal of the methanol solution would include reduction from a test strength of 26 percent to less than 1 percent by dilution or distillation. Whether methanol is used or not, methods of disposal of the test liquids are outlined by the Applicant. See Chapter 1 of Parts II, III,

IV, and V for details on disposal and water sources. Relative amounts of water that would be required to test one-mile sections of various size pipe have been calculated; 48-inch pipe would require 496,000 gallons, 42-inch pipe would require 397,000 gallons, 36-inch pipe would require 259,500 gallons, and 30-inch pipe would require 180,000 gallons.

E. Work Force

The maximum manpower involved, directly, in construction on the pipeline at any one time will probably be about 14,000 men. This peak would occur about the second or third year after approval. At that time the actual pipeline installation would be under way in Alaska, the Canadian construction would be at its peak, and the Northern Border would still be at a high level of activity.

The peak number of workers directly employed on pipeline related construction over the anticipated 8 year period of construction is presented in Table 1.OV.6-1. The figures in this table are a combination of information provided by the Applicants and extrapolations of this information. Consequently, it is not a precise presentation of the work

Table 1.OV.6-1
Projected Work Force

Line Segment	Construction Year 1	2	3	4	5	6	7	8	Total Man Years
Alaska	100	500	2,400	500					3,500
Canada	750	6,700	7,500	3,500	2,500	1,500	750		23,200
Northern Border	3,900	3,900	2,500						10,300
Los Angeles	500	2,450	210	210	150				3,520
San Francisco	300	400	400	400	400	400	400	300	3,000
	5,550	13,950	13,010	4,610	3,050	1,900	1,150	300	43,520

force for any given time period but may assist in presenting some idea of the magnitude and trend of manpower requirements.

The companies indicate that 65 percent to 75 percent of the work force will be skilled pipeline workers, such as welders, equipment operators, inspectors, and foremen. The balance of the work force will be relatively unskilled and would be hired locally.

On the Alaskan and Canadian segments construction camps will be used. These camps will range from small portable camps for up to 50 men to modular units capable of housing up to 800 employees. The type of facilities provided is dependent on the size of the camp. The smallest camps would only be on site for a few months and have self-contained waste treatment and waste disposal facilities. Camps that might serve up to 200 men and would be used for about a year would have waste disposal systems and a water supply developed on or near the site. These camps would consist of several buildings for eating, sleeping, recreation and workshops. The largest camps would be for major construction efforts and include additional personal service facilities. These camps would probably be located at the site of future compressor stations.

Pipeline construction in the conterminous States will not require camps and workers are expected to provide their own housing. This is usually done by locating quarters in communities within 50 miles of the work site or through the use of personally owned travel trailers and similar equipment.

The proposed pipeline routes in the conterminous States do not pass through any major cities but the routes do pass within less than 50 miles of 27 cities of 50,000 or more population. Although there are only two cities of 50,000 along the western routes there are an additional 27 communities of 2,500 or more within a 100 mile corridor.

Due to the nature of pipeline construction the demand on public facilities will vary. Since many activities are of short duration, workers are not expected to bring school age children with them. Commuting to and from work will add to traffic congestion and short-term demands will be placed on sewer, water, and electric utilities, recreation facilities, and other services provided by communities near the pipeline.

All companies operating in the 48 contiguous States indicate they will comply with provisions of the Occupational Safety and Health Act.

1.OV.7 Operational, Maintenance, and Emergency Procedures

A. Technical and Operational Description

Compressor stations on all segments of the system are designed to operate automatically by remote control. The individual Applicants did not specifically indicate all other facilities that would operate in this manner. Measuring stations on the Alaskan, Canadian, and Northern Border segments were identified as designed for automatic remote operation. Block valves were identified as being pressure activated except on the Northern Border where manual operation is indicated and on the Pacific Gas Transmission and Pacific Gas and Electric leg operation was unspecified.

The location of some of the gas control centers for remote operation of the pipeline have been identified as Anchorage, Alaska; Calgary, Alberta; Salt Lake City, Utah; and Los Angeles, California. These centers will receive and transmit via the system of communication towers that are to be constructed as part of the system. Gas temperature, pressure, rate of flow, and quality are some of the information that will be monitored.

Mainline block valves are located at 15 to 20 mile intervals along the pipeline, and commonly at compressor and

measuring stations. By closing these valves portions of the pipeline can be isolated for repair. Block valve assemblies generally include a blowdown valve and stack. The purpose of the blowdown valve is to vent gas to the atmosphere to clear the line or relieve a pressure build-up.

B. Maintenance Procedures

The location of scraper traps and pig launching and receiving traps has not been clearly identified. These traps are part of the in-line cleaning system. This operation is accomplished by sending an iron sphere, known as a pig, through the line under pressure. The launching and receiving traps are for the releasing or catching of cleaning pigs. In-line cleaning is part of the internal corrosion prevention control operation.

External and internal corrosion of the pipe will be monitored and checked by visual inspection and through the use of readings from test terminals attached to the pipe. In addition to the previously discussed coating, corrosion would be further prevented through the use of a cathodic protection system. The purpose of this system is to reverse the flow of current; that is, to create a flow of current

from the soil to the pipe. Effectiveness of this system would be determined from the readings from the test terminal.

All maintenance procedures have not been identified at this time. Several Applicants indicate that both operating and maintenance procedures will be set out in detailed manuals that will be available at compressor stations, maintenance sites, and other operating stations, including operating headquarters.

Right-of-way inspections which will be a continuing activity will be accomplished by aerial surveillance, motorized patrol and in some cases by foot patrol. In most cases aerial patrols will be conducted at frequency intervals of one week, two weeks or four weeks. Where aerial patrols could have an adverse effect on wildlife, foot or motorized vehicle will be used.

Compressor stations, measuring stations, and communication towers are under continuous remote monitoring. Visual inspections will be accomplished on a daily basis at some stations or at longer intervals at others when company staff visit the sites to perform operational duties.

C. Emergency Features and Procedures

Emergency features have already been discussed to some degree. The pressure activated block valves that would close off a segment of the line automatically in the event of a rupture are part of the emergency controls. Although all Applicants did not discuss these features in detail, other emergency features include fire-sensing photoelectric eyes and heat sensors that could shut down the system in the event of fire, trigger alarms in operating centers, and actually release chemicals to smother a fire. Other controls could automatically shut down portions of the line and vent gas if pressure became excessive or if equipment failure occurred.

Emergency plans will be developed by all companies to cover procedures in the event of a line break from whatever cause. These plans would consider terrain, accessibility, and climatic problems. Included would be construction diagrams, facility design, map information, equipment locations, and material inventories. Some plans will undoubtedly include information on local authorities that can be mobilized in the event of a catastrophic rupture so that local populations can be warned and control assistance

rendered. This would include local police and fire fighting personnel.

1.OV.8 Future Plans

A. Abandonment of Facilities

Since the ultimate reserves of natural gas in this region of the Arctic have yet to be determined, the future plans of the companies constructing the pipeline are rather vague. The Alaskan Arctic Gas Pipeline Company has no firm plan for termination and indicates a physical life of more than 50 years for the pipeline. If they would terminate operations, removal of the pipe would be dependent on the economics of salvaging the steel at that time. Other related facilities would be sold or salvaged. The information does not cover restoration of these sites.

On the Canadian section the Applicant indicates no specific plans for termination or abandonment. If abandonment did occur, the present concept is to leave the pipe in place; surface facilities would be removed and the sites would be restored. Any transmission capacity beyond 4.5 billion cubic feet per day will require looping and additional compressor stations. At this time, the company has no firm plan for such additional construction.

The Northern Border Pipeline Company states that the project would have a life in excess of 30 years, based on the proven reserves in the Arctic. The pipeline would have

a probable minimum life of 50 years with a 100 year life within the realm of possibility. It is also possible that the Northern Border pipeline could be used to transmit coal gas from gasification plants in Montana and North and South Dakota at some future time.

In the event of abandonment or termination, all surface facilities would be removed and the sites restored. The Northern Border Applicant states that pipe itself would also be removed and it could either be reused or sold as scrap, depending on the condition of the steel.

B. Future Expansion

Future expansion of the Northern Border pipeline includes consideration of a 42-inch looped line instead of a single 48-inch line as proposed. This possibility is more fully discussed under Chapter 8 of Part V of the Environmental Impact Statement. There are also the six additional sites that are identified as future compressor stations which would be developed to increase capacity on the proposed 48-inch line.

Pacific Gas Transmission and Pacific Gas and Electric did not provide information on the life expectancy of the

line and facilities to Antioch, California. They did indicate that if abandonment were necessary, the pipe would be removed and salvaged. Above-ground items with the exception of concrete would be salvaged and the sites restored as after construction. If capacity were to be increased above the 2,180 million cubic feet per day capacity of the proposed line, a third line with related facilities would have to be constructed. The Applicant has no plans for any of these additional facilities at this time.

The Applicants for the other leg of the West Coast line to Cajon, California do not present any plans for termination or abandonment. They indicate that if salvage were required, impacts would be similar to those encountered during construction. Their only comment on future expansion states that a pipeline paralleling the proposed route would be considered.

1.OV.9 Actions Involved

A. Federal Actions Involved

B. State/Canadian/Provincial Actions

Exclusive of the Canadian segment, all parts of the proposed gas line will require a variety of permits, authorizations, and approvals from the various levels of Government in the United States. The Federal Power Commission and the Department of the Interior have three major permit actions. These are the granting of a Certificate of Convenience and Necessity, a Presidential Permit Authorizing the Construction, Operation, and Maintenance and Connection of Facilities on the International Boundary between the United States and Canada, and the granting of right-of-way permits to cross Federal lands.

The basic actions in Canada are an application to the National Energy Board of Canada for a Certificate of Public Convenience and Necessity and for "grants of interests in Territorial Lands" from the Department of Indian Affairs and Northern Development of the Government of Canada, as well as other permits, approvals, and authorizations. Table 1.OV.9-1 lists the Federal agencies involved and their action or responsibility.

Table 1.OV.9-1
Federal Agency Responsibilities Pertaining to Pipeline Approval and Construction

Organization	Action-Responsibility
Department of Interior	
Bureau of Indian Affairs	Right-of-way approval for pipelines and compressor stations located on tribal, individually owned, and Government owned Indian lands administered by the Bureau.
Fish and Wildlife Service	Right-of-way approval for pipeline construction across National Wildlife Refuge System lands; provides consultation regarding endangered species along pipeline and their protection.
Bureau of Land Management	Right-of-way approval for pipeline construction across public lands administered by the Bureau; where pipeline construction crosses lands administered by other non-Department of Interior agencies which are intermingled with public lands administered by BLM, the Bureau grants right-of-way approval for the entire land area crossed.
Bureau of Outdoor Recreation	Recommend action on pipeline crossing of outdoor recreation areas aided from the Land and Water Conservation Fund; must concur in the granting of right-of-way across any Federal surplus property conveyed to non-Federal units of government for park and recreation purposes.
Bureau of Reclamation	Right-of-way approval across operating and authorized projects.
Bonneville Power Administration	Approval of pipeline crossings of electric transmission right-of-ways.
Federal Power Commission	Certificate of Public Convenience and Necessity, Presidential Permit and authorization to import natural gas.

Table 1.OV.9-1--Continued

Department of State	Negotiates with Canadian government and coordinates with FPC on the Presidential Permit for the International Border Crossing.
Environmental Protection Agency	Permits for the discharge of water, waste disposal, air and water quality monitoring.
Department of Transportation	
Office of Pipeline Safety	Safe operation and adherence to specifications in construction of pipeline.
Federal Aviation Administration	Air Safety, transportation of hazardous materials, air navigation communications equipment.
Coast Guard	Approves location of bridges and structures on navigable waters.
Department of Agriculture	
Forest Service	Right-of-way permits across national forests and other lands administered by the Forest Service.
Federal Communications Commission	Construction permit and station operation license for microwave transmitter and associated communication facilities.
Department of Labor	Administration of Occupational Health and Safety Act.
Department of Defense	
Air Force	Construction activities near DEW Line sites in the Arctic, rights-of-way across Air Force installations.
Army	Right-of-way permits across military installations.
Corps of Engineers	Permits involving construction on or across navigable waters.
Navy	Right-of-way permits across naval installations.

In addition, most of the States have jurisdiction and organizations holding responsibility for many of these same actions. Permits, approvals, or other clearances may be required for moving oversize vehicles on the highways; construction permits may be required; permits may be needed to draw the quantities of water that will be required; and various special construction procedures may have to be approved. Additionally, air and water standards must be met, plus waste disposal regulations and requirements relative to erosion control and interruption of drainages.

Lower units of Government such as counties, towns, and special districts can all be assumed to have similar requirements. These may in some cases be covered by a permit from a higher level of jurisdiction but not routinely. In Alaska there are local jurisdictions that must be dealt with: the Village of Kaktovik, the North Slope Borough, and the North Slope Regional Native Corporation.

2.OV Description of the Existing Environment

2.OV.1 Climate

Table 2.OV.1-1 provides summary climatological data for selected locations along the proposed pipeline route.

The text below is organized according to geographic segment because conditions vary greatly along the route. Information is provided on average and extreme temperatures, average and record rainfall and snowfall, and average and record winds. Information on growing seasons, drought periods, destructive storms, and micrometeorological conditions such as fogs and ice fogs is also presented.

Alaska

The Arctic Slope of Alaska has long, cold winters and short, cool summers with winter temperatures ranging between -20°F and -60°F (-28.9°C and 51.1°C) and summer temperatures between 40°F and 75°F (4.4°C and 23.8°C). In summer, a semi-permanent front oscillates irregularly between the Brooks Range and the Beaufort Sea. When it lies north of the coast it may warm all areas.

Table 2.OV.1-1. Summary of climatological data for representative locations along Arctic Gas System Pipeline.

Location	Average Temperatures Winter	Summer	Precipitation Annual Precipitation	Periods of Heaviest Precipitation	Annual Snowfall	Winds Average Speeds
Alaska						
4 Stations Along Proposed Route	-9°F to 1/ -12°F	32°F 2/	4-10 in. (no more than 20 in. in mts.)	July-Aug. (mostly rain)	40-55 in.	15-59 m.p.h. 3/ (coastal area)
Canada						
Aklavik, North-West Territories (on Mackenzie Delta)	-20°F 4/	55°F to 5/ 60°F	7-8 in.	July-Aug.	No more than 7 1/2 ft. (Mackenzie Delta)	12-15 m.p.h. 6/ (Beaufort Sea Coast)
Fort Simpson, Northwest Territories (62° N. Latitude)	-15°F 4/	55°F to 5/ 60°F	12-14 in.	July-Aug.	No more than 5 ft. (north of 60° N. Lat.)	6-8 m.p.h. 6/
Olds, Alberta (near Caroline Junction, Alta.)	12°F 4/	55°F 5/	18 in.	May-Sept.	49 in.	Less than 10 m.p.h. 6/
Shaunavon, Saskatchewan (near Monchy, Sask.)	12°F 4/	59°F 5/	Not Available	Not Available	Not Available	Less than 10 m.p.h. 6/
Cranbrook, Brit. Columbia (Near Kingsgate, B.C.)	15°F 4/	64°F 5/	16 in.	June (rain) Oct.-Feb. (snow)	64 in.	Less than 10 m.p.h. 6/
Northern Border						
Bismarck, N.D.	10°F 7/	72°F 8/	12-16 in.	Summer	Approx. 3 ft.	11 m.p.h. 9/
Chicago, Ill.	26°F 7/	76°F 8/	32-36 in.	Summer	More than 3 ft.	10 m.p.h. 9/
Pittsburgh, Pa.	29°F 7/	72°F 8/	36-40 in.	Summer	More than 3 ft.	10 m.p.h. 9/
West Coast (San Francisco Leg)						
Sandpoint, Id.	26°F 7/	65°F 8/	32 in.	Winter (Less than 1 in./mo., July-Aug.)	73 in.	4-10 m.p.h. 10/
Walla Walla, Wa.	33°F 7/	76°F 8/	16 in.	Winter (Less than 1 in./ month, July-Aug.)	20 in.	5 m.p.h. 10/
Klamath Falls, Or.	29°F 7/	69°F 8/	14 in.	Winter (Less than 1 in./ month, Apr.-Sept.)	48 in.	Not Available
Red Bluff, Calif.	46°F 7/	84°F 8/	32 in.	Winter (Less than 1/2 in./mo., July-Aug.)	2 in.	9 m.p.h. 10/
West Coast (Los Angeles Leg						
Winnemucca, NE	28°F 7/	74°F 8/	9 in.	Oct.-Mar.	28 in.	8 m.p.h. 10/
China Lake, Calif.	43°F 7/	86°F 8/	3 in.	Oct.-Mar.	Trace	4-7 m.p.h. 3/

1/ Average Winter Temperature
2/ Average Summer Temperature
3/ Average Wind Speeds
4/ January Daily Mean Temperature
5/ June Daily Mean Temperature
6/ Mean Hourly Winds
7/ Average January Temperature
8/ Average July Temperature
9/ Annual Mean Speed
10/ Mean Hourly Speeds

The average winter temperature along the proposed pipeline route ranges from -9°F to -12°F (22.7°C to -24.4°C) while the average summer temperature is 32°F (0°C).

The Arctic Slope area is semi-arid with annual precipitation ranging between 4 and 10 inches (10.2 and 25.4 cm). Precipitation is highest in July and August when it generally falls as rain, although snow appears in every month. The highest recorded 24-hour snowfall of 17 inches (43.2 cm) occurred in September, 1954.

Annual precipitation in the vicinity of the proposed pipeline route would not be expected to exceed 20 inches (50.8 cm) and then only in the mountain peak areas. About half of the annual precipitation is snowfall, and the average snow depth along the proposed route is expected to be less than 13 inches when construction would begin. Winds play an important role in the distribution and depth of snow at any place, with irregular low spots being filled in and high spots only thinly covered.

Along the Alaskan Arctic coastal zone persistent winds average between 15 and 59 miles per hour. The highest winds occur in the period from November through March, and in November 1970 reached 81 m.p.h. at Barter Island to the north of the proposed project area. Prevailing winds are

from the west. Wind in combination with low air temperatures produces a wind chill factor of more than -90°F during the winter.

Ice fog, formed from frozen water droplets, is a feature of arctic climate and is expected to occur at least 74 days a year at Barter Island. Without winds to dissipate it, ice fog often is confined to narrow patches along highways, construction areas, and surrounding industrial plants; it remains there until the air inversion lifts.

During a 4 to 5 week period in December and January high winds, blowing snow, and darkness create extremely hazardous flying conditions on the Arctic Slope. There is a total lack of direct sunlight in the winter months (55 days at Barter Island) during which daily temperatures range from 12°F to 15°F.

Sea ice is a dominant feature in the Beaufort Sea for 7 to 9 months of the year. Then, polar pack ice may remain quite close to the shoreline or even against it during high northerly winds. A seasonal freeze-thaw cycle controls the development and melting of the sea ice. The normal cycle begins with the formation of river and sea ice during late September when mean air temperatures fall below freezing and ice thickens to more than 6 feet. Twenty-four hours of

sunshine aid rapid thawing during late May and early June, and melting is accelerated when river flow begins on top of the river and sea ice. During the summer, westerly winds and drift force ice and water onshore. Under severe conditions sea level is raised as much as 10 feet.

Canada

The climate varies from coastal arctic near the Beaufort Sea to continental in southern Alberta, Saskatchewan, and British Columbia. Winters are generally long and cold. Summers are short and cool, but for limited periods of time may be hot. Spring and fall seasons essentially do not exist in the far North, but are distinct and progressively longer southward.

Mean temperatures along the proposed route in summer generally exceed 60°F and in winter are well below freezing. At Aklavik, Northwest Territories (on the Mackenzie Delta) daily mean temperatures reach a June high of 55° to 60°F and a January low of about -20°F. Southward at Cranbrook, British Columbia (near Kingsgate) they are about 64° and 15°F and at Shaunavon, Saskatchewan (near Monchy) 59° and 12°F. In the southern part of the region winter Chinook

winds that bring mild Pacific air often cause rapid temperature rises of 40° to 50° and daily ranges of 60° to 80°. Near Lethbridge in southern Alberta the "Chinooks" can bring temperatures of 40° or higher in one day of three during the winter. All along the route temperatures in excess of 80° and below -40° are common. The mean number of days with temperatures below freezing ranges from more than 250 at the Beaufort Sea to 200 at latitude 60° North but many hours of summer sunlight compensate in part for the short growing season. Near the Canada-United States border, mean daily temperatures below freezing occur from November to March and spot readings below 32°F have been recorded in most months.

Along most of the proposed pipeline route precipitation varies from less than 10 inches at the Beaufort Sea coast to somewhat less than 24 inches in central and southwestern Alberta. Most precipitation is in the form of summer rain, often thundershowers. North of 60° North latitude, mean annual snowfall is generally not over 5 feet with the heaviest fall usually in October. In the plains parts of Alberta and Saskatchewan annual snowfall is commonly less than 3 1/2 feet. In the mountains and foothills of Alberta and British Columbia annual snowfall is 5 to 8 feet.

Mean hourly winds decrease from about 12 to 15 m.p.h. at the Beaufort Sea coast to 6 to 8 m.p.h. in the southern part of the Mackenzie Valley. Extreme winds may be 5 or more times as high and are most common in winter. If the temperature is low enough (-22°F) during a calm period, a temperature inversion exists, and if a source of moisture such as a steaming herd of caribou or exhaust gases from combustion engines is present, ice fog may form and collect in low areas. South of latitude 60° North near the proposed pipeline route, winds are largely from the west, generally below 10 m.p.h., but with frequent storms with gusts well above 60 m.p.h. If low temperatures and even moderate winds occur at the same time, the resulting "chill factor" may seriously restrict or even make impossible human outdoor activity.

<u>Northern Border</u>

Annual average temperature ranges rather narrowly from 41°F at Fargo, North Dakota to 52°F at Columbus, Ohio. Seasonal temperature extremes are substantial. Winters in North Dakota and Minnesota are about 15°F to 20°F colder than those in Ohio and southwestern Pennsylvania. The

minimum temperature is 32°F and below more than 180 days of the year in Montana, North Dakota, South Dakota, and Minnesota.

Conversely, summer temperatures are fairly uniform along the route, with monthly averages differing by only 9°F. The western end of the route passes through a region where the freeze-free period or growing season is less than 120 days, increases to over 150 days in southern Minnesota and Iowa, 180 days in Illinois, then gradually decreases to between 120 and 150 days at the extreme eastern portion of the route.

Frost penetration is deepest in Montana, the Dakotas and Minnesota, and ranges from 70 to 80 inches in these States. Eastward, frost penetration decreases to 30 to 40 inches.

The highest recorded temperature is 115°F at Aberdeen and Pierre, South Dakota, and the lowest is -57°F at Havre, Montana.

Along the proposed route, the average annual precipitation consistently increases from west to east and ranges from 12 inches or less in Montana to 48 inches or more in the mountainous areas of West Virginia. Summer months are the wettest. Moisture evaporation rates are higher in Montana and the Dakotas than along the eastern

part of the route. The result is a moisture deficit in the western part where precipitation is least. As much as 9.3 inches of rain has fallen in a 24-hour period (Waterloo, Iowa) and more than 63 inches in a year (Dubuque, Iowa). The extreme annual snowfall ranges up to 94 inches (Columbus, Ohio).

Prevailing winds are generally southerly in summer and northerly in winter. Highest average monthly winds, 16 m.p.h., occur at Fargo, North Dakota. Blizzards are common in the Prairie and Plains States.

The principal tornado activity occurs from March to July in Iowa, Illinois, and most frequently in Indiana.

West Coast (San Francisco Leg)

From the Canadian-United States boundary to east central Washington, the proposed pipeline traverses the Northern Rocky Mountain Province; winters are cold and summers are cool. Summer precipitation here is sparse. The route then crosses the Columbia Plateau in southeastern Washington and north central Oregon. This is a semi-arid region with a more moderate climate; winter months are cool and summer months are warm.

Drought conditions occur during the summer. From central Oregon southward through the Basin and Range Province, the Southern Cascades and the Central California Valley to the pipeline's terminus, summers are hot and dry, while winters are cool and wet.

Mean annual temperatures between 46° and 48°F occur north of the Oregon-California border at the following representative locations: Sandpoint, Idaho; Spokane, Washington; Condon, Oregon; and Klamath Falls, Oregon. The mean annual temperature of Walla Walla, Washington, 54°F, reflects the milder climate of the Columbia Plateau Province. In California, mean annual temperatures are 63°F at Red Bluff and 60°F at Sacramento. Average maximum and minimum January and July temperatures for representative locations are shown in Table 2.OV.1-2. Daily maximum temperatures of 90°F or more in summer are common along the route with the exception of high elevations in the Columbia River area in Oregon. Extreme temperatures of 115°F (Sacramento, California) and -31°F (Sandpoint, Idaho) have been recorded. The length of the freeze-free period or growing season varies from 100-250 days along the proposed route.

Table 2.OV.1-2
Selected Seasonal Temperatures 1931 to 1960 For San Francisco Route

Location	Mean Annual Temperature °F	Average Maximum Temperature (January) °F	Average Minimum Temperature (January) °F	Average Maximum Temperature (July) °F	Average Minimum Temperature (July) °F	Altitude Above Mean Sea Level (Feet)
Northern Rocky Mountains Province						
Sandpoint, ID.	46	32	19	83	48	2,100
Spokane, WA.	48	31	19	86	55	2,357
Columbia Plateau Province						
Walla Walla, WA.	54	39	27	89	63	949
Condon, OR.	47	36	21	84	48	2,844
Basin and Range Province						
Klamath Falls, OR.[1]	48	37	21	85	52	4,085
Pacific Border Province						
Red Bluff, CA.[2]	63	53	37	100	68	342
Sacramento, CA.	60	53	37	93	57	17

[1]Record maximum temperature (Mt. Shasta-Chiloquin) 103° F. Record minimum temperature (Chemult)-30° F.
[2]Record maximum temperature, 114° F. Record minimum temperature, 20° F.

In general, annual rainfall is heaviest along the northern part of the route (33 inches at Sandpoint, Idaho), and decreases southward to about 14 inches at Klamath Falls, Oregon. It increases markedly at Red Bluff, California (22 inches), then decreases southward in the vicinity of Sacramento (16 inches). Lowest annual precipitation along the route is found in the grasslands of the Columbia Plateau (7-8 inches). Within provinces, rainfall is generally greater at higher elevations. It is generally greater on the windward side of mountains, and most of the pipeline route south of the Blue Mountains in north central Oregon is on the leeward side. Precipitation decreases during summer months along the route.

As much as 5.6 inches of rain has fallen in a 24-hour period (Sacramento) and nearly 13 inches in a single month (Sacramento). As much as 70 inches or more of snow falls annually along the route in the Northern Rocky Mountains and the mountains near the Columbia River.

In the Northern Rocky Mountains, prevailing winds are from the west, averaging 4-10 miles per hour; in the Basin and Range Province, from the north and northwest; and at Red Bluff, California, from the southeast averaging 9 miles per hour. Wind speeds of 50 miles per hour can be expected

every two years along the route, and maximum wind speeds up to 70 miles per hour have been recorded. Locally, mountain ranges alter wind direction and speed. Hot, dry winds, locally known as Chinook winds, are not as common along the pipeline route as those that occur along the eastern slopes of the Rockies. These winds descend the leeward side of the mountains and promote conditions favorable to forest fires or flooding, depending on the season. These winds are a possibility in any mountainous terrain along the proposed route.

Fog conditions occur 5 to 15 days annually along the route from Idaho to northern California, and 10 to 20 days southward to Antioch. They are most likely along river bottoms in fall and winter. In more humid eastern portions of the pipeline's route, sleet and ice storms may occur infrequently during the winter.

The floods of December 1964 were the most damaging in the history of Washington, Idaho, and northern California, when torrential rains measuring 20 inches fell in some areas causing severe erosion and sedimentation.

West Coast (Los Angeles Leg)

The proposed Los Angeles route coincides with the San Francisco route previously discussed for the first 206 miles through the Northern Rockies and into the Columbia Plateau in southeastern Washington. From the Plateau region, where summers are warm and winters cool, the proposed route passes south into northeastern Oregon, where (as in the Northern Rocky Mountain Province) summers are cool and winters cold. Northeastern Oregon, like southeastern Washington, often experiences drought in the summer. The route continues south through southeastern Oregon, Nevada, and California, where summers are hot and dry and winters mild.

Mean annual temperatures generally increase from north to south along the proposed Los Angeles route; the Columbia Plateau Province provides the main exception to this trend, with a relatively high 54°F at Walla Walla, Washington. Other mean annual temperatures range from 44°F at Meacham, Oregon and 46°F at Sandpoint, Idaho to 64°F at China Lake, California. Winter (January) average minimum temperatures are fairly uniform, ranging from around 20°F to 30°F along the route, but summer (July) average maximum temperatures range widely from 78°F to 102°F, as shown in Table 2.CV.1-3.

Table 2.OV.1-3
Selected Seasonal Temperatures 1931 to 1960 For Los Angeles Route

Location	Mean Annual Temperature °F	Average Maximum Temperature January °F	Average Minimum Temperature January °F	Average Maximum Temperature July °F	Average Minimum Temperature July °F	Altitude Above Level Sea Level (Feet)
Northern Rocky Mountains Province						
Sandpoint, Id.	46	32	19	83	48	2,100
Spokane, Wa.	48	31	19	86	55	2,357
Columbia Plateau Province						
Walla Walla, Wa.	54	39	27	89	63	949
Meacham, Or.	44	33	19	78	49	4,050
Basin and Range Province						
Winnemucca, Ne.	49	37	18	92	56	4,299
Tonopah, Ne.	51	44	17	91	56	not given
Bishop, Ca.	56	54	20	98	55	4,108
China Lake, Ca.	64	58	29	102	70	not given

Daily maximum temperatures of 90°F or more are common except at high elevations in the Columbia Plateau area of Oregon.

Extreme temperatures of 115°F (China Lake, California) and -36°F (Winnemucca, Nevada) have been recorded along the proposed route. The length of the freeze-free period or growing season varies from 100 days along the northern part of the route to 250 days.

Annual rainfall is generally heaviest along the northern part of the route (33 inches at Sandpoint, Idaho) and decreases southward (about three inches at China Lake, California). Annual rainfall in the mountains at the southern end of the route, however, is about 40 inches. Most rainfall along the pipeline occurs during the winter months, except in the area around Tonopah, Nevada. Approximately three-fourths of the area along the Los Angeles route receives less than ten inches of rainfall per year.

Most areas along the Los Angeles route may experience intense thunderstorms, especially in summer. As much as 3.6 inches of rain has fallen in a 24-hour period (Bishop, California) and nearly nine inches in a single month (Bishop).

As much as 100 inches or more of snow falls annually in the mountains of northwest Nevada and mountains near the Columbia River in Oregon and Washington. As much as 60 inches of snow can be expected in the high mountains near the southern terminus of the route.

Mean hourly wind speeds range from about 4 to 10 miles per hour along the route and maximum wind speeds ranging up to 81 miles per hour (in California) have been recorded. At the Oregon-Nevada boundary, it is estimated that wind speeds of 50 miles per hour can be expected every two years, and winds up to 80 miles per hour every fifty years; similar conditions can be expected elsewhere along the route. In Nevada and California, winds are generally light, from the south or west. Dust storms may occur along the route in Nevada and California in spring or summer, and strong turbulent winter winds have occurred in California. The occurrence of the Chinook winds described under the San Francisco heading above is possible but not likely along the Los Angeles route.

Fog conditions occur 5 to 15 days annually in Idaho and northeastern Oregon and 10 to 15 days in California. Occasionally, heavy fogs may settle in over locations along

the northern 1/4 of the Los Angeles route for as long as a week.

2.OV.2 Topography

On a geographic basis, topography, in its aspects of landforms or surface features (mountains, valleys) and of relief (steepness of terrain), is classed according to physiographic provinces or large areas having generally uniform topography, geology, and climate which may be divided into smaller subprovinces. Names and boundaries of physiographic provinces are by no means standardized, and in general the usage devised by Fenneman (1931) is followed. Being determined by the sum of all erosion forces, topography is important as an indicator of what erosional effects may be expected from pipeline construction and how these in turn may affect pipeline integrity.

Because of the great diversity of topographies found in each of the geographic segments traversed by the proposed pipeline route, each segment is described separately below for each of the following topics: General topographic description; geographic names of mountains and valleys; major drainage basins crossed; geomorphic description of major river channels and flood plains; elevations and elevational differences; and steepness of slopes. Many of the steepest slopes to be crossed by the proposed pipeline occur at the banks of the Mackenzie, Peace, Smoky, and

Athabaska Rivers and their tributaries in Canada. Between Caroline Junction, Alberta and Kingsgate, British Columbia, the proposed route would cross broken, precipitous mountain terrain.

Some steep, nearly vertical river banks are encountered along the proposed Northern Border route from Montana to Illinois. In the Appalachian Plateau region, mountain slopes are moderate, but there are some steep river crossings with bluffs and some crossings with eroded areas. Along the proposed San Francisco route, the pipeline would cross the steep, narrow canyons of tributaries to the Columbia River. Along the Los Angeles route, rugged terrain is encountered in southeastern Oregon.

A. General Topographic Description of Pipeline Right-of-Way

Alaska

For the first 62 miles the pipeline route follows the Arctic Coastal Plain, a nearly level and occasionally marshy

terrain with scattered thaw lakes and pingos. The latter are small isolated hills of soil-covered ice. River flood plains traverse the area from south to north, the most important being those of the Sagavanirktok and Canning Rivers.

The next 55 miles of pipeline crosses the Arctic Foothills (the foothills of the Brooks Range), rolling hilly terrain alternating with gently sloping plains and river channels. Some pingos and patterned ground occur in this area, the latter being the polygonally marked flats and stone-striped hillsides resulting from frost action and ice wedging.

Finally, a stretch of 80 miles to the Canadian Border follows the Arctic Coastal Plain again, although the terrain is intermediate between flat plain and the undulating relief of the Arctic Foothills.

Canada

The physiographic regions traversed by the pipeline route across Canada are the Arctic Coastal Plain, the Interior Plain Region (the northern extension of the Great

Plains) and the Rocky Mountain Province, where the pipeline reenters the United States.

The first 150 miles of the route follows the Arctic Coastal Plain, known as the Yukon Coastal Plain in this part of Canada's Yukon Territory. Topography is similar to the Alaskan portion of the Plain, but has many occurrences of hummocky ground due to deposits of glacial moraine. The next stretch of 150 miles is also part of the Coastal Plain; here the pipeline route skirts the Mackenzie Delta, characterized by flat terrain and occasional pingos.

From the crossing of the Mackenzie River on south for 1300 miles the route remains within the borders of the Interior Plains Province. This is a series of broad plains and low plateaus, and the principal topography-related problems are the steep river banks of the Mackenzie and its tributaries.

Finally, about 100 miles north of the United States border, one branch of the route trends westward into the Rocky Mountains Province, crossing successively the subprovinces of the Rocky Mountains Foothills, the Continental Range (with the Continental Divide), and the Rocky Mountain Trench, and entering Idaho via the Columbia Mountains and the valley of the Moyie River. This is all

broken and precipitous mountain terrain with steep-walled glacial valleys and swift streams.

The east branch of the route continues about 400 miles past Caroline Junction across the Eastern Alberta Plains and through southwestern Saskatchewan to the Montana border. The terrain is generally flat or gently sloping, with some incised river crossings, and a 20-mile stretch of sand dunes, the Great Sand Hills, south of the Saskatchewan River. There is also a 10-mile badlands area south of the Frenchman River, just north of the border.

<u>Northern Border</u>

From the Canadian Border to eastern South Dakota, the pipeline route continues across the Great Plains Province. Entering the province of the Central Lowlands, it moves across the East Central States to central Ohio, where the Appalachian Plateau Province begins.

Topography of this region is controlled by its location at the headwaters of the Mississippi and its tributaries, and by its history of continental glaciation. Along its western portion, the Great Plains route is not dissimilar to its Canadian counterpart. The badlands noted along the

Frenchman River (Frenchman Creek in Montana) appear sporadically along that stream and Rock Creek in Montana, and the Little Missouri River in North Dakota. The subprovince here is the Glaciated Missouri Plateau; the route continues through North Dakota along the Unglaciated Missouri Plateau, a region of level terrain except for the 2-mile traverse of the Killdeer Mountains, then reenters the Glaciated Plateau near the South Dakota boundary. Here the route descends the gentle slope of the Missouri Coteau escarpment to enter a region of small lakes and potholes, the Western Lake Subprovince of the Central Lowlands. A second gentle escarpment rises some 55 miles to the east; this is the Coteau des Prairies.

The route continues eastward to cross, in Iowa, the Dissected (eroded) Till Plains Subprovince of the Central Lowlands, and the Till Plains Subprovince extending through Illinois, Indiana, and eastern Ohio. Except for moderately steep escarpments along the Illinois and Wabash Rivers, this area has little of topographic interest.

The easternmost section of the route lies in the Appalachian Plateau, comprising the Southern New York, Kenowna, and Allegheny Mountain Subprovinces. Typically,

the country is mountainous, but slopes are moderate with some river crossings presenting bluffs and eroded areas.

West Coast (San Francisco Leg)

The proposed San Francisco leg, extending southward from the Idaho-Canada Border, traverses in succession the Rocky Mountains Province, the Columbia Plateau Province of Washington and Oregon, the Blue Mountains and High Lava Plains Provinces, the Basin and Range Province in southern Oregon, the Modoc Plateau Province into California, and the Central Valley Province near San Francisco. (Some of these terms are not standardized, some surveys omitting the Blue Mountains, High Lava Plains, and Modoc Plateau designations.)

The first part of the route, through the Northern Rocky Mountains Subprovinces, is laid out along the nearly-level valley floors of the Moyie River and the Purcell Trench, but requires several river crossings. Entering the Walla Walla Subprovince of the Columbia Plateau, it crosses gently rolling terrain, but occasionally stretches of rough eroded scablands. In the southern part of this region it

encounters the steeply walled tributaries of the Columbia River.

In central Oregon, the route encounters in succession the Blue Mountains and High Lava Plains Provinces, considerably elevated but not otherwise notable in a topographic sense. Then it trends eastward into the broad Basin and Range region of interior drainage, not far from Klamath Falls, Oregon. It crosses the California Border and enters the Modoc Plateau Province, where the terrain - lava beds and volcanic remnants - is rough and irregular. The last portion of the route drops down into the gently rolling terrain of the northern Central Valley of California and the flat Sacramento Delta.

West Coast (Los Angeles Leg)

For the proposed pipeline from the Idaho-Canada Border to the Los Angeles area, the northern routing of 206 miles coincides with the San Francisco route described in the preceding section, i.e., crossing the Northern Rocky Mountains and Columbia Plateau areas. At a point some 35 miles north of the Washington-Oregon Border the two lines diverge, the Los Angeles line striking southward across the

Blue Mountains, Owyhee Upland, and Basin and Range Provinces to terminate in the Transverse Ranges east of Los Angeles.

The route throughout the greater part of Oregon crosses the eastern portion of the Blue Mountains Province. This is an area of varied topography, mountainous in its northern parts, the southern part grading into the basalt flows and terraces of the Owyhee Uplands. Crossing into Nevada, the route enters the extensive Basin and Range Province, to traverse a series of open valleys presenting no difficult topographic features throughout that State.

The California portion of the Basin and Range Province, from the Nevada Border to the terminal at Cajon, includes mountainous terrain east and south of the Owens Valley. Otherwise, the route traverses a generally flat or gently sloping desert, part of the Mohave Subprovince.

B. Geographic Names of Mountains, Valleys, or Other Features Crossed

<u>Alaska</u>

Commencing at Prudhoe Bay, which opens on Alaska's northern coast to the Beaufort Sea, a portion of the Arctic Ocean, the pipeline route is laid out in an easterly

direction across the North Slope, the terrain between the sea and the Brooks Range of mountains. It crosses the Sagavanirktok, Canning, and a number of smaller rivers, and reaches the Canadian Border about 200 miles from its origin.

Canada

The northernmost part of the route enters the Yukon Territory, crosses the Yukon Coastal Plain on Canada's Arctic Coast and, passing into the Northwest Territories, skirts the southern part of the Mackenzie River Delta. It then trends southward to ascend the Mackenzie River Valley, passing the settlements of Fort Good Hope, Norman Wells, Fort Norman, and Wrigley. Leaving the Mackenzie Valley, it crosses the Liard River and enters Alberta Province. The Hay River and its tributaries are crossed near the border, and in the center of the province, the Peace and Athabaska Rivers. Crossing the North Saskatchewan River, the route branches at Caroline Junction north of Calgary, Alberta. The Monchy Delivery Line continues in an easterly direction to join the Northern Border route at Morgan, Montana; the Kingsgate Delivery Line continues southward through the

Rocky Mountains to Eastport, Idaho, where it joins the San Francisco and Los Angeles pipeline routes.

Northern Border

In the United States, the eastward route crosses the Great Plains of northeastern Montana, first the Frenchman Creek area with its associated badlands, then (omitting small tributaries to the Missouri River) the Poplar River and Big Muddy Creek. Entering North Dakota, the route crosses the Missouri River near Williston and goes over a divide in the Killdeer Mountains. The Missouri River is crossed a second time at the Oahe Reservoir, and the route enters South Dakota.

Descending the gently sloping Missouri Coteau, the route now crosses the Central Lowlands. In South Dakota it crosses the James River and ascends another gentle rise, the Coteau des Prairies. The Big Sioux River is crossed in the eastern part of the State.

No major geographic features are encountered in southwestern Minnesota. In Iowa the routing is across the Iowan Drift (local) Plains and the Cedar River. The

Mississippi is crossed near Rock Island and Moline, Illinois.

The principal river crossing in Illinois is that of the Illinois River. In central Indiana the Wabash crossing is made, and in the Central Lowlands of Ohio, the Scioto River and its tributaries. Here the route enters the Appalachian Plateau.

Crossing the Ohio River above Wheeling, West Virginia, the route continues across the Monongahela and Youghiogheny Rivers to its terminal in western Pennsylvania.

<u>West Coast (San Francisco Leg)</u>

From Eastport, Idaho, the routing to San Francisco follows the Moyie River Valley and the Purcell Trench, a long structural valley which the route follows to the Pend Oreille River. Crossing the river, the route continues over the Rathdrum Prairie and over the Spokane River near the Washington Border. Two other major river crossings are made in that State, the Snake River and the Walla Walla River, where the route parallels Lake Wallula as it enters Oregon.

Crossing the Umatilla River, the route continues southwesterly across the John Day Canyon, and detours around Klamath Lake as it approaches the California Border.

In California the route crosses the Modoc Lava Beds and passes near Mt. Lassen Volcano to enter the Central Valley. It crosses the Sacramento River in the northern part of that valley, and again in the south. The last major river crossing is that of the San Joaquin River, at the pipeline terminal.

West Coast (Los Angeles Leg)

The Los Angeles route begins in the north with the portion common to it and the San Francisco route, as described in the preceding section. In southern Washington an independent routing is begun, crossing into Oregon in the Blue Mountains region.

The route first crosses the Umatilla River, follows Horseshoe Ridge, and descends to the Grande Ronde Valley. Passing the Craig Mountains, it crosses the Powder River twice, then follows the Baker and Sutton Creek Valleys. Crossing the Burnt River and the Durkee Valley, the route enters the Owyhee Uplands. The principal river crossings

here are the Malheur and the Owyhee, tributaries to the Snake River. Ascending Blue Mountain Pass, the route enters the Basin and Range Province and the State of Nevada.

The routing in Nevada crosses two principal mountain terrains, the Clan Alpine and New Pass Ranges, but in general follows the intermountain basins. From north to south, these are the Quinn, Paradise, Grass, Pleasant, Dixie, Edwards Creek, Smith Creek, and Ione Valleys. At Fish Lake Valley the route crosses into California.

The California portion of the route comprises the White Mountains, the Owens Valley, and the Mohave Desert, which is the approach to the terminal at Cajon Pass in the San Bernardino Mountains.

C. General Drainage Characteristics

1) Major Drainage Basins Crossed

Alaska

The Alaska portion of the route drains northward into the Arctic Ocean through a series of relatively short and straight rivers, arising in the Philip Smith and Davidson Mountains of the Brooks Range.

Canada

All but the extreme northwest and southeast portions of the route drains into the Arctic Ocean through a series of rivers and lakes debouching into Mackenzie Bay, comprising the second largest drainage system on the continent.

Drainage along the Yukon Coast is directly into the Beaufort Sea extension of the Arctic Ocean. From the Mackenzie Delta southward nearly to Alberta Province, the route lies in the drainage basin of the Mackenzie River itself. Lesser drainage basins to the south in Alberta are those of the Peace and Athabaska Rivers, which are part of the same overall system.

In south-central Alberta, drainage is eastward by way of the Saskatchewan River Basin to the Hudson Bay.

Where the Kingsgate Delivery Line in southern Alberta crosses the Continental Divide, it enters the regime of drainage to the Pacific Ocean by way of the tributaries of the Columbia River. Similarly, the eastern branch near the Montana Border enters the Missouri River drainage basin, which discharges its waters to the Gulf of Mexico.

Northern Border

From Montana to Iowa, the pipeline route lies within the Missouri River Basin, which is the major portion of the Mississippi drainage system. In Iowa, the drainage goes directly to the Mississippi, and moving east along the route, drainage remains the same until the Indiana-Ohio Border is reached. In western Ohio, a short stretch drains into the Atlantic by way of the Maumee River and the Great Lakes. Thereafter the drainage is directed into the Ohio River Basin, ending with the Monongahela-Youghiogheny tributary to the Ohio in western Pennsylvania.

West Coast (San Francisco Leg)

The predominant drainage pattern for that portion of the route from Idaho to San Francisco is toward the Pacific Ocean via three drainage basins. The northernmost is that of the Columbia River, which receives tributary waters down to central Oregon. In the southern part of that State, a relatively small stretch lies within the Basin and Range Province, draining into various isolated depressions with no outlet to the sea. Another small portion of the route lies within the Klamath River Basin of southern Oregon,

discharging into the Pacific. Finally, the route enters the regime of the Sacramento River, which, with its companion river in the south, the San Joaquin, drains the Central Valley of California by way of San Francisco Bay.

West Coast (Los Angeles Leg)

The initial drainage along the northern portion of the Los Angeles route, like that of the San Francisco route described in the preceding section, is westward through the Columbia River system. Thereafter, through eastern Oregon, it is drained by the Snake River and various tributaries, all part of the Columbia River system.

Where it enters Nevada, the route is subject to the interior drainage of the Basin and Range Province, the waters of which are lost by evaporation. This drainage remains unchanged until the southern terminal is reached in California.

2) Geomorphic Description of Major River Channels, Flood Plains, and Other Related Features

Alaska

Alaska's Coastal Plain is relatively long, narrow, and nearly flat, and the usual dendritic drainage pattern is absent. Instead the pattern is that of a number of parallel streams which develop broad floodplains and braided channels as they approach the coast. This is the condition of the Sagavanirktok and Canning Rivers, the two principal streams in the area.

A problem peculiar to rivers in the Far North is the development of aufeis, a thick burden of ice that constricts the underflowing water and forces it to seek new channels. This in turn promotes the development of an intricately braided channel system.

Canada

Rivers in Canada's Yukon Coastal Plain develop in a similar manner to those of the adjoining Alaska Plain.

The Mackenzie River Delta, whose southern margin is crossed by the pipeline, is one of the largest deltaic systems on the continent, reflecting the size of its

drainage basin. Like other major Arctic rivers, the Mackenzie does not carry a high proportion of sediment, and its delta is not extended out to sea as, for example, that of the Mississippi. Rather, it consists of a broad area of numerous major channels and intervening islands.

Above Fort McPherson the geomorphology of the river valley is determined largely by its recent history of glaciation. The Laurentide and earlier ice sheets scoured large lake basins (Great Bear and Great Slave Lakes), and deposited barriers of morainal material and till, which now appear as steep river banks and channel deposits. The same forces have shaped the river channels southward to the Canadian Border.

Northern Border

As in Canada, river development in the North Central States has been conditioned by glacial scouring, till and moraine deposition, and melting. In addition, the scanty vegetation of the semiarid western Great Plains has resulted in the erosion of V-shaped valleys, eroded banks, and deeply incised channels of the Missouri River tributaries in

Montana and North Dakota. Farther southeast are thick loessial deposits, which often erode, along waterways, into nearly vertical banks. The floodplain of the Mississippi River, moreover, was built by a considerably larger stream, the result of glacier melting, allowing room for meanders.

The next major river to the east, the Illinois, has a narrow V-shaped valley at the location of the pipeline crossing. Broader valleys are evident throughout the remaining Central Lowlands portion of the route, but in the Appalachian Plateau country, narrow V-shaped valleys with little or no floodplain are once again characteristic of rivers of the area, particularly the Monongahela and Youghiogheny.

West Coast (San Francisco Leg)

The Northern Rocky Mountains of Idaho show the effects of valley glaciation, the carving of U-shaped valleys which are generally oversized for the streams that occupy them today. In addition, a long grabenlike depression, the Purcell Trench, serves as a part of the projected route, so that the Idaho portion of the route is a fairly open one.

On the Columbia Plateau to the south, the major river crossing is that of the 2000 foot wide channel of the Snake

River. Southward, the height of the plateau above the Columbia River results in some very deeply incised tributary valleys or, more appropriately, canyons. That of the John Day River is a narrow, deeply incised V-shape where the route descends 2000 feet from the plateau. Farther south, the Cow Canyon crossing of Antelope Creek presents a lesser descent of like profile.

In the Oregon portion of the Basin and Range Province intermittent streams, or dry washes, are the rule. These are often undersized for the basins they occupy, and have broad, low-banked channels.

The adjoining Modoc Plateau, in its southern portion, has moderately deep V-shaped valleys, now in the process of being cut down to the level of the Sacramento Valley to the west.

The Sacramento River itself varies in profile from a low, open V-shape to the broad flood plain and braided-channel delta approaching the San Francisco Bay area. Artificial levees are raised in the delta portions of the Sacramento and San Joaquin Rivers to protect the farmlands, and in one instance (Sherman Island) because the land has subsided below sea level.

West Coast (Los Angeles Leg)

From the Idaho-Canada Border to their separation in southern Washington, the Los Angeles route shares river valleys in common with the San Francisco route described in the preceding section. Thereafter it enters the Blue Mountains and Owyhee Uplands Provinces of eastern Oregon. The river valleys vary from open to V-shaped; those of the Powder River and Willow Creek are examples of the former, while the latter are represented by such streams as the Cottonwood Creek in the Owyhee area. The Malheur River in this area, however, has a floodplain over two miles wide.

To the south, the steep-walled canyon topography is continued until the route enters the Basin and Range Province. In this province, rainfall is scanty and seasonal, and such streams as exist are nearly all intermittent. The route crosses thousands of small dry washes which descend from the mountains, often down broad alluvial fans, to widen their channels and eventually disappear in the desert landscape.

In California the Owens River, in a deep grabenlike valley below Mt. Whitney, is one of the few perennial streams found along this part of the route. Southward, the

Mohave Desert and the intermittent Mohave River resume the pattern of Basin and Range geomorphology.

D. Average, Maximum, and Minimum Elevations Along the Route: Differences in Elevations Between Prominent Mountains and Adjacent Valleys

The overall relief - differences in elevation between topographic high and low points - gives a measure of insight into slope stability and problems attendant on pipeline laying in precipitous mountain terrain. It should be borne in mind, however, that in the more arid portions of the West, weathering rates are slow, and high relief does not necessarily indicate unstable ground.

Ranges of relief shown here are usually those shown on topographic maps for a given landform association, e.g., two mountain ranges and their included valley, traversed by the pipeline. These ranges are by no means a complete listing, but are intended to be representative of the various subprovinces.

Alaska

The Arctic Coastal Plain portion of the proposed pipeline route, between 0 and 30 miles from Prudhoe Bay, has a maximum elevation of 75 feet and a minimum of 0 feet (sea level), representing a range of 75 feet.

The Arctic Foothills and Coastal Plain portion of the route, between 30 and 195 miles from Prudhoe Bay (to the Canadian Border) has a maximum elevation of 825 feet and a minimum of 50 feet, representing a range of 75 feet.

The highest topographic feature adjacent to the route has an elevation of 1300 feet; the lowest 0 feet (sea level), for an overall range of 1300 feet.

Canada

The Yukon Coastal Plain and Mackenzie Delta portions of the route have a maximum elevation of 645 feet near Milepost 336 from Prudhoe Bay, and a minimum of 0 feet (sea level), for an overall range of 645 feet. The local relief ranges up to 250 feet.

Within the Interior Plain, the maximum elevation is 4,120 feet, south of the Athabaska River, and the minimum 65 feet at the Mackenzie River, with local relief ranging up to

600 feet. In this same physiographic province, the branch extending to the Montana Border has a maximum elevation of 3,800 feet, with local relief to 500 feet.

The branch extending to the Idaho Border, passing through the Northern Rocky Mountains Subprovince, has a maximum elevation of 7,000 feet, and a minimum of 2,300 feet. Local relief is as high as 1,000 feet, while the overall relief of the surrounding country ranges up to 3,000 feet.

Northern Border

The proposed route reaches its highest elevation of 3,050 feet near the Montana Border, and declines gradually to a minimum of 460 feet at the Illinois River crossing in the Central lowlands. The local relief along this portion ranges up to 600 feet at the crossings of the Missouri and Little Missouri Rivers, and 850 feet where the route crosses the Killdeer Mountains in North Dakota.

In the Appalachian Plateau Province, near the eastern extremity of the route, it rises once more to an elevation of 1,400 feet, 2 miles from its terminal.

The average elevation over the entire route is about 1,200 feet.

West Coast (San Francisco Leg)

In the Northern Rocky Mountains, a maximum elevation of 2,900 feet is reached north of Freeman, Washington, and a minimum of 1,800 feet in the Moyie River Valley. Local relief along the route ranges up to 600 feet, but in the adjacent mountains relief may be up to 4,000 feet.

The Columbia Plateau region to the south has a maximum elevation, for the pipeline route, of 3,500 feet above Cow Canyon, and a minimum of 400 feet at the Walla Walla River. Local relief ranges as high as 2,000 feet at John Day Canyon, but the average lies between 200 and 400 feet. Average elevation along the route is about 1,800 feet.

Elevations along the route in the Blue Mountains Province of Oregon range from 3,000 feet maximum to 2,000 feet minimum.

For the High Lava Plains Province, also in Oregon, the maximum pipeline route elevation is 4,600 feet, no minimum being noted.

The Basin and Range Province in Oregon has a maximum elevation along the route of 5,300 feet, with the minimum unspecified. The local relief is up to 500 feet.

The Modoc Plateau Province is rugged, with a maximum route elevation of 6,100 feet at Burney Mountain and a minimum of 300 feet at its southern extremity in the Sacramento Valley. Deeply incised canyons provide local relief of 800 to 900 feet along the actual route of the pipeline.

In the Central California Valley the pipeline route attains a maximum elevation of 400 feet and a minimum of 0 feet (sea level). The local relief at stream crossings is as much as 50 feet.

West Coast (Los Angeles Leg)

In the Northern Rocky Mountains and Columbia Plateau Provinces, elevations and relief for this route are as described for the corresponding portions of the San Francisco route in the preceding section.

The route in the Blue Mountains Province of Oregon reaches a maximum elevation of 4,020 feet near Encina.

Local relief ranges to 1,000 feet, with overall relief in the neighboring mountains as high as 3,000 feet.

The Owyhee Plateau Province of southern Oregon has a maximum elevation along the route of 5,250 feet at Blue Mountains Pass, the southern limit of the province. Local relief ranges up to 600 feet, with differences in elevation of nearby landforms as great as 3,000 feet.

The adjoining Basin and Range Province extends southward through Nevada to the southern terminal in California. Within this province the maximum route elevation is 6,500 feet, south of Smith Creek Valley, Nevada and also in the Cedar Mountains of that State. The low elevation is 2,300 feet near China Lake, California. The differences in elevation of surrounding terrain range from 1,000 to 3,000 feet.

E. Steepness and/or Angles of Slopes Traversed

<u>Alaska</u>

The Alaska Coastal Plain is flat or gently sloping, with 90 percent of the slopes traversed being less than 3°. Steep terrain, therefore, is substantially limited to river banks, classed as very steep when they exceed slope angles

of 35°, steep when greater than 14° and less than 35°, and moderately steep when between 6° and 14°.

Canada

Excepting the Kingsgate Delivery Line in southern Alberta, the typical pipeline terrain is nearly flat, with slopes less than 1°. This is coastal plain, river delta and valley, and large expanses of muskeg. Consequently, steep slopes are for the greater part associated with river banks, particularly the short, swift tributaries of the Mackenzie River. Only a few of these, however, are classed as very steep.

Farther south, the many tributaries of the Peace, Smoky, and Athabaska Rivers present occasional crossings rated as moderately steep to very steep. Intervening stretches are largely flat lake and muskeg country.

Moderately sloping terrain is found in the Northern Rocky Mountains crossing of the Kingsgate Delivery Line before it dips into the Moyie River Valley near the Idaho Border. The same is true of the badlands traversed by the eastern branch in the Frenchman River area near the Montana Border.

Northern Border

Almost the whole route from the Montana Border to the terminal in western Pennsylvania lies in the upper drainage area of the Mississippi River, characterized by gently rolling prairie and flat agricultural and lakeland. (A few miles of routing in western Ohio lie within the Great Lakes Basin.) The region on the average ranges from nearly flat to very gently sloping, i.e., less than 1° slope, with the exception of its western and eastern extremities.

Moderate to steep slopes in the West occur in the Montana and North Dakota Badlands, comprising up to a third of the terrain in that area. Occasional gentle to moderate slopes are encountered farther east, notably in the crossing of the Killdeer Mountains of western North Dakota, the ramplike Couteau de Missouri, and the counterslope, the Couteau des Prairies, in eastern South Dakota. As elsewhere, however, the river banks make up the greater number of steep slopes. Those of the Illinois River in Illinois, and its tributary, the Pecumangen Creek, have slope angles ranging from 30 to 60 percent.

In the East, the rivers of the Appalachian Plateau present slopes classed as very steep. Mine subsidence pits

may have moderately steep slopes, which are likely to be less stable than their natural counterparts.

West Coast (San Francisco Leg)

Along the entire right-of-way, 64 miles of slopes are classed as moderately steep to very steep, of which 9 miles exceed a slope angle of 25 percent. On the first few miles of the route below the Canadian Border, there are 4 such slopes.

Short but steep slopes are encountered again in the Columbia Plateau Scablands of west central Washington. Long steep to very steep slopes are traversed in the canyon of the John Day River in northern Oregon. The terrain from here southward through the Blue Mountains and High Lava Plains of Oregon is one of numerous gentle to moderate slopes. The Basin and Range Province in the southern part of the State is one of lengthy but gentle slopes, except for the few river crossings. Entering the Modoc Plateau of California, the route at first encounters similar terrain; this, however, roughens and presents slopes of 30 to 35 percent in the North Fork Bear Creek Canyon. Then the route enters the Sacramento Valley portion of the Central Valley

of California, and slopes diminish to moderately steep or less. The southern part of the valley, in the Sacramento Delta, is flat.

West Coast (Los Angeles Leg)

Sharing the topography of the San Francisco route (see preceding section) until they diverge in Washington, the Los Angeles route crosses the Blue Mountains in eastern Oregon, encountering steep slopes between the Powder and Burnt Rivers, and again near Willow Creek, where it traverses a small badland area. Here it enters the Owyhee Uplands, with steep to very steep slopes along the deeply incised canyon sides. The route continues through southern Oregon through similar rugged terrain.

Entering Nevada, the route remains in the Basin and Range Province until it terminates in California's San Bernardino Mountains. As the name indicates, the basins traversed are mainly broad and open, with interior drainage, and bounded on all sides by long, very gentle to gentle slopes and alluvial fans. A few steep slopes are encountered crossing the hills and ridges that form the northern limit of the Mohave Desert.

2.OV.3 Geology

This section includes descriptions of bedrock, surficial deposits, and mineral deposits along the proposed route. The following geologic hazards and conditions are also described: earthquakes, faults, landslides and other mass movement, permafrost, and volcanism.

Bedrock, surficial deposits, and mineral deposits found along the proposed route vary widely in character and their description has therefore been organized into geographic segments. In most locations along the route, unconsolidated surficial deposits from 10 to several hundred feet deep cover the bedrock. Bedrock is found less than 10 feet below the surface along no more than 5 percent of the Alaska route, along some 150 miles of the route through the Appalachian Plateau, in parts of the Northern Rocky Mountains, the Columbia Plateau, and the mountains of eastern Oregon, and in parts of Nevada and California crossed by the proposed route. Oil and gas deposits are found along the route in Alaska, Canada, and at the western and eastern ends of the North Border segment; gas fields also occur along the Sacramento Valley portion of the San Francisco segment. The potential for discovery of coal deposits along the Alaska segment is good, and coal is mined

along the southern part of the Canada segment and the western and eastern ends of the North Border segment.

Each geographic segment of the route crosses areas of seismic activity; areas of greatest earthquake potential along the route are near the Yukon-Northwest Territories boundary, in eastern Indiana and western Ohio, in the Umatilla-Walla Walla region and the region near Antioch along the San Francisco segment, and along the southern half of the Los Angeles segment. A known geologic fault is located 10 to 20 miles southwest of the route in Montana, and a number of faults are crossed or approached along the southern half of the San Francisco segment and along the Los Angeles segment in Nevada and California. The potential for landslides occurs along portions of all segments of the proposed route.

This section also describes permafrost conditions along the Alaska segment and the northern portion of the Canadian segment, and associated engineering problems. The potential for volcanic action along portions of the San Francisco and Los Angeles segments is discussed.

A. General Description

1) Bedrock and Surficial Deposits

Bedrock is chiefly weakly cemented sedimentary rock ranging from mudstones to conglomerates along the proposed route in Alaska. On the Arctic Coastal Plain the rocks are nearly flat-lying to gently folded. In the Arctic Foothills, these rocks have been deformed into east-west trending fold structures. The bedrock is overlain by unconsolidated surficial deposits 10 to more than 150 feet thick along most of the proposed route in Alaska. The unconsolidated materials are mostly sandy and gravelly with a mantle of fine-grained deposits. Organic-rich silt is common in depressions.

The bedrock along the proposed route in Canada is a sequence of layered rocks, ranging from locally hard metamorphosed varieties such as quartzite and argillite to more extensive poorly consolidated shale. Intermediate types including limestone, sandstone, and conglomerate predominate. In most of the area these bedded rocks are nearly flat-lying. In the Franklin Mountains and in southern British Columbia, however, the rocks have been extensively faulted and folded. In the plains areas bedrock exposures are chiefly limited to steep slopes at stream

crossings. In the mountains bedrock is commonly at or near the surface. Unconsolidated surficial deposits generally from 10 to 40 feet thick cover the bedrock. The unconsolidated deposits are chiefly glacial moraines and lesser amounts of lacustrine silt, clay, and some sand. The moraines are composed chiefly of till, a mixture of sand and coarser fragments in a muddy matrix of silt and clay. Organic-rich silt mantles the surface in many places, and ice-rich soils are common.

The bedrock along the proposed route from the U.S.-Montana border to Pennsylvania consists of interbedded layered hard and soft sedimentary rocks. Along the eastern half of the route the rocks are mostly soft shale and claystone with some interbedded hard sandstone. Along the eastern half of the route, the rocks are mostly hard and the sedimentary sequence includes limestone and coal. The rocks are mostly nearly flat lying except for in the Appalachian Plateau where they have been deformed into a series of north-northeast trending folds. The bedrock is covered by unconsolidated surficial deposits from a few tens of feet to about 650 feet thick along about 80 percent of the proposed route from the Montana-Canadian border to Pennsylvania. Surficial deposits are less than 10 feet thick principally

along the part of the route in the Appalachian Plateau. The surficial deposits are varied in grain size and origin, but are largely glacial. West of the Appalachian Plateau, till is common. There are lesser amounts of wind and stream deposited silt and coarse-grained alluvium.

Bedrock is diverse along the routes from the U.S.-Canadian border to the San Francisco and Los Angeles areas. In the Northern Rocky Mountains Province, the bedrock is chiefly a complex association of metamorphic and granitic rocks. Most of these crystalline rocks are covered by unconsolidated surficial deposits that are tens to hundreds of feet thick. In scattered areas, surficial deposits form only a thin mantle over bedrock. The surficial deposits in the Northern Rocky Mountains portions of the routes are predominantly glacial and fluvioglacial materials that range from boulder moraines to clay and fine silt. Intermittently the route crosses flood plain deposits.

Bedrock along the proposed West Coast routes is chiefly of volcanic origin in the Columbia Plateau and southward for about 600 miles to the Central Valley of California and the Basin and Range Provinces in Nevada. Much of the bedrock of the Columbia Plateau is covered by unconsolidated surficial deposits from a few inches to more than 100 feet thick.

These surficial deposits are predominantly loess and rock fragments in the Columbia Plateau.

On the proposed route to San Francisco, alluvium and lake deposits, derived chiefly from volcanic materials, form a thick to thin cover over bedrock between the Columbia Plateau and the Central Valley of California. In the Central Valley the proposed route crosses poorly consolidated sedimentary rocks covered by thick deposits of unconsolidated deposits that range from clayey silt to small cobble gravel.

Along the proposed route to Los Angeles, bedrock in the area between the Columbia Plateau and the Basin and Range Province is mostly covered only by a thin veneer of loess and coarser materials. Thicker deposits of surficial materials are encountered only in major valleys where the route crosses recent terrace and flood plain deposits of mixed sand, silt, and gravel.

Bedrock along the route to Los Angeles in the Basin and Range Province consists of a mixture of hard welded tuff and lava flows and soft relatively unindurated tuffs and sediments. A series of alluvial fans and ancient lakes form thick unconsolidated deposits on the bedrock. Grain size is very variable ranging from mostly all silt and clay in some

places, and elsewhere a mixture including cobbles and large boulders; locally they are partly indurated by carbonate cement. Southward through California the geology is more complex; in addition to volcanic rocks, the proposed route crosses exposures of chiefly sedimentary rocks. Faulting of the rocks is common, and in places they are intricately folded and matamorphosed. Bedrock is deeply buried by alluvial deposits in the major valleys.

2) Mineral Deposits

In the Alaskan segment hydrocarbons predominate among economic deposits. The entire Alaskan North Slope has large petroleum reserves, both known and potential. Potential exists for additional fields in the Beaufort Sea. The potential for discovery of coal deposits is thought to be good, although the area is largely unexplored.

There is a geothermal resource potential within the Arctic National Wildlife Range, but the Geothermal Steam Act of 1970 prohibits leasing in wildlife refuges or ranges.

There is good potential that metallic mineral deposits occur locally within the mountains south of the

proposed route. Gravel is being extracted or processed along the proposed route.

Along the Canadian segment, there are extensive known and potential oil and gas deposits. There has been no significant production of nonfuel mineral deposits except in southeastern British Columbia. There has been prospecting for lead and zinc along the Mackenzie River, and sand and gravel are common. Bituminous coal occurs in the southern Rocky Mountains, and sub-bituminous coal and lignite occur in large areas of the plains in southern Alberta and Saskatchewan.

The principal geologic resources available along the Northern Border segment are large deposits of coal, lignite, natural gas, and petroleum. These are mainly near the two ends of the proposed route in eastern Montana, western North Dakota, eastern Ohio, and western Pennsylvania. Lesser amounts are present in Illinois and western Ohio. Present production is almost wholly in the four States first named.

Non-fuel deposits include sand and gravel, building stone, and salt. Limestone for crushing and dimension stone is extensively quarried in the Central Lowlands and Appalachian Provinces.

Along the San Francisco leg there are no high grade or commercial metallic mineral deposits. Nonmetallic deposits are limited chiefly to sand and gravel and crushed stone. Scattered areas in the central portion have geothermal resource potential, and there are some gas fields in the Sacramento Valley Province.

Along the Los Angeles segment commercial metallic mineral deposits are known only in the Basin and Range Province. Mercury, gold, silver, and other metals have been mined within 10 miles of the proposed route. Nonmetallic deposits are limited chiefly to sand and gravel and crushed stone. Some areas in northern Nevada have geothermal resource potential.

B. Geologic Hazards

1) Earthquakes

Each segment of the proposed route crosses areas of seismic activity. The recorded seismic history along the proposed route, especially in the North, is quite short and is only a limited guide to future seismic risk. Earthquakes of magnitude 6 and larger on the Richter scale are

potentially destructive, and those of magnitude 5 may cause damage locally.

Earthquake activity along the proposed Alaskan segment is low. Since the mid-1960's several shocks between magnitude 4.0 and 4.7 have occurred within about 40 miles of the route between longitudes 143° and 146°W. The maximum expectable earthquake is magnitude 5.5.

Earthquake activity along the proposed route in Canada varies from a maximum in the vicinity of the Yukon-Northwest Territories boundary to a minimum in Alberta. From the Alaska-Yukon border south to the lower 48 States the route traverses all four seismic risk classifications incorporated in the 1970 revision of the seismic zoning map for Canada (Stevens and Milne, 1973, Figure 1).

The earthquake potential along the pipeline route may be specified in terms of maximum expectable earthquakes as shown in Table 2.OV.3-1.

Table 2.OV.3-1

Maximum Expectable Earthquake Magnitudes

Along Proposed Canadian Route

Segment	Magnitude
Alaska Border to 138°W	5.5
138°W to Arctic Red River	7.0
Arctic Red River to 65°N	5.0
65°N to 62°N	6.0
62°N to 55°N	4.5
55°N to Milepost 1447	5.5
Kingsgate Delivery Line	
Milepost 1447 to Idaho Border	5.5
Monchy Delivery Line	
Milepost 1447 to Montana Border	4.5

Along most of the Northern Border segment the proposed route passes through zones in which no damage or only minor damage is expectable. In the eastern part of the Central Lowlands, however, there is increased risk. Here, there have been earthquakes capable of causing moderate to considerable damage.

The San Francisco leg traverses areas of greater seismic activity and risk. The most seismically active parts are the Umatilla-Walla Walla region where the maximum expectable magnitude is 6, and the Southern Great Valley-Antioch region where the maximum expectable magnitude is 8. Elsewhere the route passes through known seismic zones, but no or only minor damage is expectable.

Most of the Los Angeles segment crosses areas where moderate to major damage may be expected from earthquakes. The southern half includes areas of greater seismic activity and higher risk than any other part of the proposed pipeline system. Table 2.OV.3-2 summarizes the maximum expectable magnitude for the most active part of the route.

Table 2.OV.3-2

Maximum Expectable Earthquake Magnitudes

Along Los Angeles Route

	Maximum Expectable Magnitude
Walla Walla Region	6
Oregon	5 1/2
Pleasant Valley	7 3/4
Dixie Valley and vicinity	7 1/4
Cedar Mountain vicinity	7 1/2
Cedar Mountain to Owens Valley	6 3/4
Owens Valley to Indian Wells Valley	8 3/4
Indian Wells Valley through the Mojave Desert	8
Cajon Canyon to Los Angeles	8 1/2

2) Faults

No active faults are known from reconnaissance geologic mapping along the Alaskan and Canadian segments of the proposed route. In those areas, and elsewhere where only reconnaissance-type data are available, detailed geologic field investigations might reveal evidence of recent movements.

In the Northern Border segment there is a known fault 10 to 20 miles southwest of the proposed route in Montana. The possibility exists that this fault extends northeast and crosses the route.

There are a number of active faults with a predominant north-northwest orientation in the vicinity of the southern half of the proposed San Francisco segment that have been correlated with recorded seismicity.

The proposed pipeline route along the Los Angeles segment in Nevada and California closely approaches or crosses a number of active faults with varied orientations, and terminates about 3 miles from the main trace of the San Andreas fault. This segment of the San Andreas is considered capable of producing a magnitude 8 to 8.3 earthquake.

C. Landslides--Mass Movement

Landslides and related processes of mass movement of earth materials occur along various portions of the proposed route. Along the Alaskan segment mass movement of soil and rock materials is primarily associated with slope stability in permafrost. In permafrost regions, slope stability is very sensitive to the amount of water in the material, and instability is not uncommon on slopes as small as 3° and may occur on lower slopes.

Solifluction, the downslope movement of water-saturated unfrozen sediments overlying frozen material, is probably the most important expression of slope instability in the Arctic portion of the proposed pipeline. Downslope movements may be so rapid that a structure in the area of movement will be subjected to large earth pressures, or will move passively downslope. Solifluction is limited to periods of thaw, and is most severe on fine-grained ice-rich materials on steeper slopes.

Along the Canadian segment, in addition to solifluction, other types of mass movement resulting in slumping and landslides occurs in some areas of shale on steep slopes. A prominent example of this is where the proposed route crosses the Peace River in Alberta, near Milepost 1112.

Along the Northern Border segment landslides, and to a much lesser extent rockslides, have occurred in the vicinity of the proposed route at numerous localities along valley walls. They are located mainly in the vicinity and west of the Oahe Reservoir, and throughout the Appalachian Plateau Province. Rockfalls and mudflows are also known in these areas.

Many landslides have occurred in the vicinity of the San Francisco leg, especially in the Columbia Plateau and Blue Mountain Provinces. Areas most susceptible to sliding are steep slopes where bentonitic (a type of clay) tuff is interbedded with basalt. The proposed route crosses such areas, including a large landslide in the John Day Formation, on such a steep slope that future movement is almost certain.

Along the Los Angeles segment there are scattered areas of similar landslide potential in the Blue Mountains and Owyhee Upland Provinces. There also has been minor landslide activity in the California section, and the proposed route crosses existing landslide deposits in Owens Valley.

D. Permafrost

Permafrost is defined as soil, rock, or any other earth material, the temperature of which remains at or below 32°F (0°C) continuously for two or more years (Muller, 1974, p. 3). A surficial layer that is seasonally thawed and frozen is termed the active layer, and is commonly 1 to 3 feet thick.

Although ice is not a necessary prerequisite of permafrost, its presence and amount in relative proportion to soil, bedrock, and other earth material is of extreme importance to construction in the Arctic. The amount of ice can vary from none to nearly 100 percent. Generally, bedrock and well-drained coarse sediments have little or no ice, and poorly drained, fine-grained sediments contain large amounts of ice. It is thawing of the permafrost beneath the active layer that is of primary concern to construction in the Arctic. Thawing of the permafrost results from disturbing the natural surface, as in construction and transfer of heat from buildings and other installations. The engineering problems resulting from such thawing relate to the potential loss of strength and volume (Ferrians et al., 1969). In ice-rich material, which is common along the route, this can cause severe differential

settlement or loss of bearing strength in foundations. Such effects may be self-perpetuating and difficult to predict. The entire proposed route in Alaska is in the zone of continuous permafrost. Within this zone permafrost occurs everywhere, except beneath large water bodies, and is commonly several hundred feet thick, and in places as much as 2,000 feet thick.

In Canada, this zone of continuous permafrost extends south to about Travaillant Lake Junction, where the thickness decreases to about 200 feet. Within the zone of discontinuous permafrost south of Travaillant Lake Junction, the areal extent and thickness of permafrost generally decreases southward. There is essentially no permafrost south of about 58° North latitude. Near the southern limit, the permafrost occurs only in scattered areas up to several acres.

E. Volcanism

Because of the youthful age of the volcanic terrain along parts of the San Francisco leg, and locally along the Los Angeles leg, potential volcanic eruptions must be considered a major geologic hazard. Eruptions could produce

ash falls, or flows of ash, mud, or lava that could cut the proposed pipeline.

2.OV.4 Soils

This section provides information on soil types, physical characteristics, principal uses, drainage characteristics, erosion potential, and susceptibility to frost action. The discussion is organized according to geographic segment in order to accurately describe the variety of conditions found along the proposed route. The proposed route would cross agriculturally productive soils in the Norman Wells-Wrigley area and the Hay Lake Drainage in the Northwest Territories, in the Peace River Valley in Alberta Province, from South Dakota east through the Cornbelt to Ohio, and in the Central California Valley. Soil productivity is low in southeastern Oregon, Nevada, and south central California due to lack of moisture; it is also low in the Arctic where a change in any component of the delicately balanced ecosystem affects all other components.

Areas highly susceptible to erosion include the Upland Foothills of the Alaskan Arctic, the Richardson Mountains region of the Mackenzie Delta, parts of the route through the breaks of Frenchman's Creek in Montana and the Badlands in North Dakota, portions of eastern Ohio, slopes in West Virginia and Pennsylvania, the Rocky Mountains in British Columbia and Idaho, lands between the John Day River and

Bend, Oregon, the Sierra Nevadas north of the Central California Valley, and parts of Nevada and south central California. Areas moderately susceptible to erosion include the Klamath and Shasta Basins. Areas of low susceptibility to erosion include the Arctic Coastal Plain, land along the Monchy Delivery Line through Alberta and Saskatchewan, parts of Montana and North Dakota, and the Cornbelt. Erosion potential increases where soils are shallow, in foothills, and at river and stream crossings.

In the Alaskan and Canadian Arctic, soils are highly susceptible to frost action or frost heave. Additional information on soils along the proposed pipeline route follows.

Alaska

From Prudhoe Bay to the Canadian border the Alaska route traverses three major soil types: the poorly drained soils of the coastal plains, the poorly drained alluvium soils of major drainages, and the poorly to well drained soils of the Arctic Foothills.

The dominant soils are those of the Arctic Coastal Plain which are crossed along approximately 75 percent of the

route. These are loam to silt loam soils on slopes from 0-3 percent. They are poorly drained and have a dark peaty surface layer. Susceptibility to frost action is high but erosion is low to moderate. Included in this general soil unit are extensive areas of terraces bordering large drainages where frost action is moderate and the soils are better drained.

The alluvial soils which occupy the flood plains and alluvial fans of major drainages are silt loams and stratified sands on slopes of 0-3 percent. The soils are shallow, permeability is moderate to rapid, susceptibility to frost action is high but erosion potential is low. These soils are encountered along approximately 20 percent of the route.

The upland soils of the Arctic Foothills are crossed for only about 5 miles. These soils occur on steep slopes (12-45 percent) in the mountains, in narrow valleys, and on footslopes. They are usually well drained and vary from very gravelly to silt and sandy loams. Susceptibility to both frost action and erosion is high.

Because of the climate all of the soils along the Alaska segment are poorly developed. Soil development rarely

exceeds 5 feet. Nitrogen deficiencies are common and permafrost is encountered at shallow depths.

Detailed soils information is not available for this portion of Alaska. A reconnaissance survey by the Applicant involving 55 test holes along the route indicates the subsoil conditions shown in Table 2.OV.4-1.

Table 2.OV.4-1

Alaskan Subsoil Conditions by Percentage

Glacial deposits	37.9%
Alluvial deposits	29.0%
Marine deposits	20.1%
Lacustrine (lake) deposits	2.7%
Diverse deposits	10.2%

<u>Canada</u>

From Demarcation Point to the Yukon-Northwest Territory boundary the route traverses level to gently undulating tundra soils. These are poorly drained, weakly developed soils of fine to medium texture. Productivity is low because of high pH and low oxygen and nutrient values. The soils are susceptible to frost action and frequently contain

permafrost at shallow depths. Common frost related features include frost boils, ice wedge polygons and thermokarsts.

From Inuvik and Fort McPherson to south of Travaillant Lake Junction the area along the route is level to rolling except where it skirts the Richardson Mountains. Soils are fine to medium textured and formed of only slightly modified parent materials. They are generally well drained with only a thin mineral-organic surface horizon.

In the vicinity of the Richardson Mountains the soils are shallow and stony with actively eroding surfaces. They occur on steep slopes that are highly susceptible to erosion when disturbed.

Along the level to undulating slopes of the Mackenzie River Valley the route traverses organic soils where decomposition is slow and permafrost tables are close to the surface. These poorly drained soils consist of bogs and fens. Water tables are below the surface in the peat bogs but frequently at the surface in the fens.

Between Norman Wells and Wrigley the route traverses the alluvial soils of the Mackenzie River Valley which are underlain with till and lacustrine deposits. This is highly productive timber land. Local accumulations of river silts are highly fertile and produce good garden crops.

After leaving the vicinity of the Mackenzie River the route traverses level to rolling slopes of fine to medium textured soils underlain with glacial and lacustrine deposits. These soils produce good pasture and woodlands and are considered arable in the Hay Lake Basin. In the extreme northwest corner of Alberta these are high elevation areas of organic soils frozen at a depth of 2 feet. Bog areas used for pasture and woodland are common.

Along the slopes of the Peace River Valley medium to fine textured soils on nearly level land have developed on slightly saline lacustrine sediments. These soils are extensively farmed in the Peace River district.

From the Peace River to the division of the route at Caroline Junction the soils are on level to rolling land and have fine to medium textured surface soils underlain by glacial till materials.

The Kingsgate Delivery Line from Caroline Junction to the Alberta-British Columbia border traverses grassland soils of the prairie regions characterized by dark-colored mineral-organic surface horizons.

Across the Rocky Mountains the route will traverse deeply eroded mountainous terrain with coarse shallow soils. The steep slopes present severe erosion hazards.

In the Kootenai River Valley the route crosses excessively drained terraces on the drainage slopes and poorly drained alluviums in the river bottom. Stoniness, high lime content and high clearing cost limit agricultural usage.

In the vicinity of Kingsgate soils are derived from iron-rich volcanic deposits. They are medium textured and fertile but occur on steep slopes having high erosion hazards.

The entire Monchy Delivery Line traverses the mixed grass prairie soils used for grazing and spring wheat production. Except at the breaks associated with drainage crossings the soils are deep, medium to fine textured, and on level to moderately sloping terrain.

Northern Border

The Northern Border segment traverses a wide variety of soils along its 1,600-mile route from the western rangelands of Montana to the eastern woodlands of Pennsylvania.

Through Montana and the Dakotas the route is in the Northern Great Plains where land use is essentially equally divided between livestock production and the growing of

spring wheat. Soils vary from deep loams and clay loams on level to gently rolling topography, to very steep shallow soils underlain with shales and sandstone. The shallow soils on steep slopes are generally associated with eroded drainageways while the deep agricultural soils occur on the plains, terraces, benches, and alluvial fans.

In Montana approximately 25 miles of steep shallow soils will be crossed at the breaks of Frenchmans Creek and other south-flowing drainages. Soils through this area are highly susceptible to erosion.

About 120 miles of the route through North Dakota crosses the Little Missouri Badlands and the Missouri River Escarpment. Soils through these areas are extremely thin over shales and sandstone. Slopes range up to 60 percent with elevational differences of 400 feet. Erosion hazards are high.

From the crossing of the Missouri River in south central North Dakota through the northeast portion of South Dakota, the route traverses the prairie pothole regions of the Missouri Coteau, the James River Lowlands, and the Coteau de Prairie. This is a poorly drained area containing many wetlands. Soils are rather uniform with one to two feet of rich loamy topsoil over a variety of glacial till materials.

The topography is level to gently rolling. In some areas subsoils contain high proportions of clay. On old stream terraces and outwash plains, sandy and gravelly materials underlie the prairie topsoils. Water tables are naturally close to the surface but extensive tile drainage systems have converted much of the land to highly productive cropland.

Through the southwest corner of Minnesota the route crosses the southern extremity of the Minnesota lake country and enters the cornbelt of the Midwest. While local soil variations are common the glacial till plains from Minnesota to central Ohio present an extensive area of great soil uniformity.

Rich topsoils developed from tall grass prairie vegetation are underlain by a variety of glacial till and outwash materials. Soils vary in texture from sandy loams to clay loams on level to nearly level slopes. Most topsoils are two to three feet deep and are devoted to intensive agriculture. Major crops include corn and soybeans. While high seasonal water tables occur over most of the Midwest cornbelt, they are kept at depths of 3 1/2 to 4 feet by extensive tile drainage systems. Because of the level topography and deep soils, erosion hazards are low

across the cornbelt. Exceptions may occur where sandy outwash areas are subject to wind erosion and where stream courses are crossed.

For approximately 100 miles in eastern Ohio the route crosses the Appalachian Province where slopes are steep and soils are shallow over shale and sandstone. This is an area of high erosion hazard. In addition to soil and slope problems, high water tables in acidic soils and numerous small stream crossings will be encountered. For approximately 7 miles an area of unstable spoil piles from coal strip mining will be crossed. These reconstituted soils are highly acidic and composed of relatively sterile subsoils.

Through West Virginia and Pennsylvania to the terminus at Delmont the route crosses the unglaciated Appalachian oak forests. Soils are generally very shallow over parent shales, siltstones, and sandstones and occur on steep slopes dissected by numerous drainages. Valley bottoms may contain rather deep loamy alluvium soils devoted to pasture and crop production. Some soils contain high seasonal water tables.

West Coast (San Francisco Leg)

From Eastport, Idaho, southward to Spokane, Washington, the San Francisco route crosses soils developed on outwash plains, flood plains, and morainal and lake deposits derived from continental glaciation. The soils occur on steep forested mountains to nearly level flood plains. They support productive forest and grassland vegetation. On gentle slopes and flood plains the soils are devoted to agriculture. About 27 miles of this segment contains soils that are highly erosive if cover is removed.

From the Snake River crossing in Washington the San Francisco line bears southwesterly through the southern portion of the Columbia Plateau. Soils that formed in windblown loess that contains volcanic ash are dominant. They are generally sandy and occur on gentle to moderately steep slopes. Alluvium soils are found in the larger flood plains and shallow soils occupy steep slopes of scablands and canyons. Nearly half of the land is dry farmed and produces good yields of wheat, peas, and hay. About two-fifths of the land is used for livestock grazing and small areas are wooded.

From the John Day River to Bend, Oregon, the route crosses the Upper Snake River Lava Plains. Soils are silty

and sandy, shallow to moderately deep, and occur on gentle to very steep slopes. About 34 miles of this section is highly susceptible to wind and water erosion. About three-fourths of the land is used for livestock grazing. Lumbering, recreation, and wildlife uses are important in the wooded portions.

From Bend, Oregon, the route traverses the Klamath and Shasta Basins. Soils are loamy to silty clay, shallow to moderately deep and occur on nearly level valley floors to moderate slopes of the uplands. Major uses include lumbering on the higher mountain slopes and grazing of range and open woodlands. Soils are moderately susceptible to erosion.

Before entering the Central Valley of California the route crosses the northern extremity of the Sierra Nevada Range. This is an area of shallow soils and steep slopes that extends for about 70 miles along the route. Local relief at the Pit River, Old Cow Creek, and North Fork of Bear Creek varies from 500-900 feet at canyon crossings. Most of the land is forested and is used for timber production, recreation, and wildlife habitat. Range lands are used for summer grazing. Erosion hazards are very high because of steep slopes and shallow soils.

At Red Bluff, California, the route enters the Sacramento Valley where soils range from loamy sands to silty clays, shallow to moderately deep on broad nearly level valleys, alluvial fans, and slightly eroded terraces. About 163 miles of the route contains high shrink-swell soils. About one-third of the area is used for livestock grazing. About half of the area contains highly productive irrigated cropland that produces fruits, nuts, grapes, hay and grain. Erosion hazards will be relatively low except in the foothills areas and at stream crossings.

West Coast (Los Angeles Leg)

Southwesterly from the Snake River Crossing across the Columbia Plateau to the Blue Mountains the Los Angeles route crosses wind-deposited soils (loess) that are sandy to silty and occur on plateaus and rolling hills. The land is used for range and dry cropland with timber stands on some slopes. A few areas of high shrink-swell clay soils are encountered.

Across Malheur County, Oregon, the route traverses the Malheur High Plateau. Soils are moderately alkaline, coarse loamy or silty, moderately deep and occur on semi-desert

terraces and lakebeds. Range for livestock is the principal use. Production is low because of lack of moisture.

South across Nevada the route traverses a semi-desert region of sodic flood plains, plateaus, basins, and isolated mountain ranges. Soils are low in productivity because of limited moisture. They are shallow and frequently underlain with cemented carbonate accumulations. Drainage is generally poor and high runoff during infrequent high intensity storms causes flooding and high rates of erosion. These soils are subject to severe erosion from both wind and water when protection is removed.

In California the route crosses the southern portion of the Nevada Basin and the Sonoran Basin. This is a semi-desert to desert region. Soils are shallow and poorly developed. They vary from coarse loamy to sandy textures underlain by a thin cemented clayey layer or carbonate layer. Alluvial fans and barren mountains with steep slopes are common. Vegetation is sparse but a "desert pavement" or gravelly mantle provides surface protection. On steep slopes the soils are unstable and when disturbed erosion hazards are high.

2.OV.5 Water Resources

This section identifies proposed pipeline crossings of rivers and other major water bodies; provides water quality, run-off and flow data; and describes groundwater sources and public water supplies along the proposed route. The proposed route crosses some 120 streams and rivers in Alaska. In Canada, it crosses more than 50 streams and rivers which have drainage areas greater than 300 square miles above the pipeline crossing. The Northern Border route crosses some 1,492 rivers and streams, but only 12 of these are considered major. The San Francisco portion of the route has 26 major river crossings. The Los Angeles route has 27 major river crossings, plus crossings of 70 or more creeks and numerous intermittent streams and dry washes.

The largest river drainages, with their seasons of peak flow or potential flooding, are listed in Table 2.OV.5-1. Many of the rivers and streams in the Upper Missouri River Basin and the Columbia River Basin are regulated through storage in lakes and reservoirs. Additional information on water resources along the proposed route follows.

Table 2.OV.5-1
Major River Drainages Crossed by Arctic
Gas Pipeline System

Rivers	Peak Flow or Potential Flood Seasons
Rivers of Arctic Coastal Plain and Foothills	Flooding, late May or early June.
Mackenzie Drainage	Maximum flow May or June; flooding possible spring or summer.
Upper Missouri River Basin	Maximum flow May to July; flash floods possible in summer.
Mississippi River	Maximum flow April or May; secondary maximum flow possible in October or November.
Ohio River Basin	Highest monthly run-off in January in western part of basin; peak flows in March or April in eastern parts; high summer flows possible due to summer storms.
Columbia River Basin	Maximum flows May and June; floods possible in spring.
John Day, Crooked River, and Other Streams in North Central Oregon	Summer flooding possible due to summer cloud bursts.
Klamath River Basin	Maximum flows winter or early spring.
Walla Walla and Umatilla River Basins	Flooding possible in winter due to intense winter rainstorms.
Desert Washes in Nevada	Flash floods possible under rare conditions.

Alaska

The Arctic Coastal Plain contains thousands of shallow lakes and ponds, a number of wide, braided rivers, and many small streams that meander extensively. The Arctic Foothills contain swift, braided rivers and a few thaw lakes. Rock-basin lakes are scattered through the mountains. The major rivers and streams of the Arctic Slope drainage originate in the Brooks Range.

Permafrost generally tends to block the downward movement of water, causing it to flow through the "active thaw layer" or over the tundra.

Runoff is dominated by snowmelt and characterized by a major spring flooding which occurs in late May or early June. During the balance of the open-water season, flow generally declines. This recession of flow is punctuated by periodic frontal storm runoff with peak flows occasionally exceeding those generated by snowmelt. During the winter months flows decline to a very low level, and in most streams, cease by late November or December.

Snowdrifts or occasionally aufeis may create small dams that impound water until they break and the pond is released. Such releases are often additive and cause floods. Such floods usually dissipate quickly in steep,

rough channels, but within a mile or two of their source they are likely to be more destructive than any other flow event.

There are no glacier-dammed lakes in any basin along the proposed route that might cause a major flood event.

The proposed pipeline crosses 120 streams between Prudhoe Bay and the Canadian border. One hundred of these streams are categorized as tundra, 19 as mountain or mountain glacier, and one as spring fed. Available data indicate that the mean annual daily maximum discharge rates range from near 30 cubic feet per second per square mile (cfsm) in the coastal plain to near 10 cfsm in the mountains. Mean annual peak rates reported are as much as 50 cfsm. The mean annual low flow is reported at less than 0.1 cfsm.

Water quality characteristics on streams of the Arctic Slope are good. The pH of the Sagavanirktok River is generally between 7.5 and 8.0; Happy Valley Creek is usually close to neutral; Chamberlain Creek had a pH of 6.5 during the summer of 1958. Dissolved oxygen is usually high in the Sagavanirktok River and in Happy Valley Creek because of relatively low temperature and biological activity.

The erosion and deposition of sediments have not been studied extensively. These processes probably occur primarily during spring breakup.

Lakes are prevalent in the Coastal Plain, and in some areas account for 80 percent of the total surface area. In general, the fresh waters of the North Slope that are not influenced by the ocean are dilute calcium bicarbonate waters.

Groundwater conditions along the proposed route vary because of the presence of permafrost. Groundwater is usually located under rivers so deep that they do not freeze solid each winter. The resource has not been developed or explored to any significant extent in the Arctic Slope drainage.

The eastern portion of the Brooks Range, where sandstone and shale overlie the limestone, contains numerous springs. Large areas of aufeis are associated with springs in the area. Almost all of the springs are located south of the proposed route. A few perennial groundwater sources are also located on the Arctic Coastal Plain.

The quality of the shallow groundwater is of calcium bicarbonate type, usually with less than 250 mg/l (milligrams per liter) of dissolved solids.

Canada

The principal drainage system crossed by the Canadian part of the proposed pipeline is the Mackenzie River. The Mackenzie River and its tributaries drain about 700,000 square miles, making it the second largest river in North America, both in size of drainage area and magnitude of discharge. The Prudhoe Bay Supply Line crosses several rivers that drain directly into the Arctic Ocean. In southern Canada the proposed pipeline crosses the basins of the North and South Saskatchewan Rivers of the Nelson River system, Kootenay River of the Columbia River system, and Milk River tributaries of the Missouri River system.

The average annual runoff is less than 1 inch in southeastern Alberta and southwestern Saskatchewan and more than 40 inches near the crest of the Rocky Mountains. During the winter many of the streams have no flow and many of the shallow lakes and wetlands are completely frozen. Some streams flow during the winter months because they are downstream of large lakes or connected to groundwater reservoirs. Floods can occur because of spring breakup and ice jams, snowmelt runoff, summer storms, or a combination of conditions. The Mackenzie River at Norman Wells

experienced its highest recorded maximum daily flow of 900,000 cfs (cubic feet per second) on July 25, 1972.

The magnitude of flow varies seasonally. Stream flow figures for major streams are found in Chapter 2, Part III. Low runoff occurs in late winter when precipitation is stored as snow and ice. Maximum flow usually occurs as the result of snowmelt in May or June.

No glaciers are located immediately along the proposed pipeline. However, glacier activity in the headwaters affects the flow and quality of glacier-fed streams crossed by the proposed route. On the Arctic Coastal Plain all of the proposed pipeline is in the continuous permafrost zone; permafrost may affect summer stream flow by reducing infiltration, increasing flood runoff and reducing basal flow. There is also a high probability that icing (or aufeis) will develop along this portion of the route; aufeis is a layered sheet of ice formed on a river flood plain in winter when shallow places in the river freeze or are otherwise dammed, causing water to spread over the flood plain and freeze.

In general, the rivers along the proposed route have water of good quality, soft to moderately hard. At the extreme southern end of the pipeline some of the stream

water contains large amounts of alkali sulfate and is of poor quality. Available data show that the dissolved-solids concentration of surface waters range from less than 25 mg/l to more than 2,000 mg/l. The higher concentrations of dissolved solids usually occur during the low-flow period in the winter. Dissolved-oxygen values ranged from near saturation to near 0 for some streams under ice cover in winter. During peak flows in spring and summer, the dissolved oxygen in many rivers of the Mackenzie Basin is at less than 60 percent saturation when sediment transport is high. Suspended-sediment concentrations vary from less than 5 mg/l during low flow periods to more than 3,500 mg/l during summer high runoff events.

Throughout the Arctic Coastal Plain and the Mackenzie River Valley, the present sources of municipal and industrial pollution effect no major changes in the water quality. Along the Nelson River, Columbia River and Mississippi-Missouri River Systems a clean water supply exists and no unsatisfactory conditions occur with respect to dissolved oxygen, turbidity, pH, total hardness, chloride, or bacteriological constituents.

The proposed pipeline route may be divided into segments that cross each of three hydrologic regions: The Northern,

the Interior Plains, and the Cordilleran. The Northern Region is differentiated principally because of the overriding effect of permafrost on groundwater. The Northern Region includes, from north to south, parts of the Yukon Coastal Plain, the Mackenzie Delta, and those subdivisions of the Interior Plains physiographic region within the permafrost area. The Interior Plains Region includes all of the plains region east of the Rocky Mountain front and south of the southern limit of discontinuous permafrost to the Canadian-United States border. About 100 miles south of Calgary the Kingsgate Delivery Line enters the Cordilleran Region.

Groundwater is not available for water supplies throughout most of the Northern Region because of permafrost conditions. Groundwater is generally available in the Interior and Cordilleran Regions. Where the proposed route crosses streams, surficial deposits commonly consist of alluvium. These deposits are good aquifers where not frozen, and may contain large quantities of groundwater.

Soil material, which includes the seasonally thawed zone (active layer) on and just below ground surface, is not a good aquifer, but does transmit surficial groundwater and

frequently contains ground ice. Water may move freely or be frozen as ice in this zone, depending on the season.

South of the discontinuous permafrost zone, many farms must use shallow wells on till deposits, which are poor aquifers often yielding less than 5 gpm (gallons per minute). However, some of the wells developed in outwash or recent alluvial deposits along stream courses yield from 10 to 75 gpm. Most municipalities and industries obtain their water from sandstone, or from the alluvial sands and gravels.

In the Cordilleran Region, groundwater supplies have not been extensively developed, but large quantities of water may be obtainable.

In the permafrost and discontinuous permafrost zones, the information on water quality indicates that groundwaters are calcium bicarbonate in type and have low dissolved-solid concentrations. Groundwater in the surficial deposits south of the permafrost zone, in the more arid parts of Alberta, generally is a calcium-sulfate type of water that is very hard and high in dissolved minerals. In southern and eastern Alberta, dissolved-solid concentrations exceed 2,500 mg/l. However, in the West where precipitation is greater, the water has a low dissolved-solid concentration.

Northern Border

In the Upper Missouri River basin, the first of three major drainage-basins crossed by the pipeline route, stream flow is highly variable. Low-flow conditions occur from September through May, and maximum flow conditions from May to July. Consequently, larger streams are extensively regulated. Runoff along the proposed route in the upper Missouri basin ranges from 1/4 inch per year from the glacially-influenced James River to slightly over one inch per year in the basins of the Cannonball and Little Missouri Rivers.

The Missouri River, at the two crossings in North Dakota, has a mean discharge rate of 20,000 cfs (cubic feet per second). The peak flow on record on the Missouri River was 231,000 cfs prior to upstream regulation.

Severe summer thunderstorms, such as one experienced at Stanton, North Dakota in which nearly 13 inches of rain fell in 2 hours, can cause disastrous flash floods in the short, steep coulees along the Missouri River and its tributaries. Runoff rates as high as 1,000 cfs per square mile have been recorded.

Annual sedimentation rates within the Upper Missouri basin vary from less than 100 tons per square mile in the

arid, previously glaciated areas to more than 2,000 tons per square mile in the badland-type terrain. The Missouri River has an annual sediment discharge of about 100 million tons.

Surface water quality throughout the western Great Plains is generally adequate and dissolved solids are less than 500 mg/l in most areas. Eastward, water contains lesser dissolved solids but pollution problems become more prevalent.

In Minnesota, the pipeline route crosses the divide into the upper Mississippi River basin, back into the Missouri basin for a short distance, and then re-enters the Mississippi River basin, the second major drainage basin traversed by the route. Southward into Iowa the route approximately parallels the Cedar River. Peak flows in this area generally result from spring runoff, augmented by spring and early summer rains. Intense storms may occur during the summer and fall and cause high flows of brief duration. Winter freezeup is the most common cause of extended periods of low flow.

At Clinton, Iowa, 15 miles above the proposed route crossing, the Mississippi River has a mean flow of 47,000 cfs. Peak flow generally occurs in April or May, but high autumn precipitation, groundwater recharge, and low

evapotranspiration may combine to create a secondary maximum in October or November in some wet years.

Water quality in the Mississippi River basin is generally good, dissolved solids range between 200 and 900 mg/l, and local pollution is encountered.

The route enters the Ohio River basin, the third major drainage basin crossed by the route, in Indiana. Hydrologic characteristics of the area include a relatively high average annual precipitation rate, from about 36 to 44 inches, combined with relatively low runoff. The highest monthly runoff usually occurs in January in the western part of the basin. Spring thaws create annual peaks in March or April in the eastern parts of the basin. Superimposed on this pattern are regional summer storms that have caused the largest flows of record in some tributary basins. Runoff rates are reduced throughout the basin by the high infiltration rates of glacial deposits. Most of the streams in the basin are extensively regulated.

The Ohio River, gaged seven miles downstream from the proposed crossing, has had a maximum daily discharge of 412,000 cfs during 18 years of record. Mean daily discharge during the period is 40,850 cfs. The crossing site is

affected by backwater from a dam located four miles downstream.

Pollution problems of the Wabash River are indicative of most streams in the Ohio River basin. High concentrations of pollutants result from sewage treatment plants, food processing plants, and paper mills. Metal finishing industries add deleterious concentrations of heavy metals, and electric-generating plants are a source of thermal pollution. At times, dissolved oxygen levels have dropped to as low as 3.0 mg/l. In streams outside of the glaciated are, acid mine drainage is a problem.

Communities along the pipeline route use both surface and groundwater for water supplies depending upon available supplies and quality. Over the central part of the route, groundwater sources dominate--only Fairmont in Minnesota and Clear Lake in Iowa use surface water sources in those States. In Ohio, St. Mary's, Columbus, Delaware, Newark, and Dennison obtain supplies from surface water, as do all communities along the Ohio River in West Virginia and Pennsylvania.

Groundwater occurs in a complex series of both shallow and deep aquifers along the route. In Montana, shallow aquifers are formed by glacial outwash deposits and Tertiary

sandstone units with intercalated gravel beds. Over most of the route in Montana, only unconsolidated deposits would be intersected by the trenching operation. Much of the groundwater in the area is of very poor quality; the best quality water is found in relatively thick alluvial or outwash deposits, but dissolved solids may range as high as 2,000 mg/l even there. Principal constituents are calcium, magnesium, and sulfate.

In North Dakota, potable groundwater occurs within 20 miles of the proposed route in Cretaceous sandstone units, Tertiary gravels, Quaternary glacial deposits, and Holocene alluvium. Artesian water is locally present in the deeper aquifers. Quality is highly variable, and the best quality water is found in glacial outwash deposits.

Similar groundwater conditions prevail along the route in South Dakota and Minnesota, with a progressive change eastward to older, less permeable water-bearing units at depth. Water is highly mineralized in both States, but the range of quality in individual aquifers is large. For example, within the glacial drift of one county, specific conductance ranges from about 250 to 5,900 micromhos per centimeter.

In Iowa, Illinois, and Indiana, thick deposits of glacial drift cover most of the route and are underlain by predominantly flat-lying sandstone or carbonate aquifers of Paleozoic age. Yields as high as 1,500 gallons per minute have been reported from individual wells. The quality of water in most aquifers is good and much is suitable for domestic uses.

Groundwater in Ohio is derived principally from bedrock aquifers, but local surficial deposits, especially valley trains in eastern Ohio, are important. Bedrock aquifers are also important in West Virginia and Pennsylvania. Water from the surficial aquifers is commonly of better quality. Some contamination of both shallow and deep aquifers has occurred from acid mine water.

West Coast (San Francisco Leg)

After originating at the international boundary the proposed pipeline continues in a southwesterly direction through Idaho, eastern Washington, central Oregon, and Nevada to its terminal at Antioch, California. Lake Britton, a reservoir on the Pit River, is the only lake crossed. Crossings of 18 major streams at 26 sites are

planned. The principal rivers are the Moyie (8 crossings), Kootenai, Pend Oreille, Spokane, John Day, Snake and Sacramento. About one-half of the streams are extensively regulated through storage in reservoirs and lakes. In the important Columbia River Basin, the size of drainage areas varies widely, but the hydrology of the basins is in many ways similar. All the rivers crossed originate in the highlands where much of the precipitation is snowfall, and maximum flows, usually from snowmelt, occur in May and June. Minimum flows generally occur in late summer.

Streams between the John Day and the Crooked River in northern central Oregon have flooded in the past due to summertime cloud bursts. Stream flow figures and flood recurrence figures for 50-, 100-, and 200-year intervals are found in Chapter 2, Part IV. A disastrous flood of 36,000 cfs (cubic feet per second) in the Willow Creek at Heppner, Oregon occurred in 1903 and took the lives of more than 200 people. Located at the confluence of several ravines, the town has experienced many cloudburst floods.

Southward in the Klamath River Basin, Oregon, streams have their maximum flows in winter or early spring, and some are sustained throughout the year by large springs.

Drainage patterns are poorly developed in the Basin and Range Province crossed by the route in northern California, and the landscape includes numerous marshes and lakes. Mean annual runoff is in the range 2 to 5 inches. The Pit and Fall Rivers and many smaller perennial streams are crossed in the generally volcanic terrain sloping westward into the California Central Valley and along the west side of the Sacramento Valley near the junction of the Sacramento and San Joaquin Rivers.

Surface water in the northern part is typically clear of suspended sediment at low flow and substantial loads of suspended sediment occur at high flow. Along the proposed San Francisco leg, sedimentation is greatest for the Walla Walla River where a maximum suspended-sediment concentration and discharge (daily basis) of 61,200 milligrams per liter and 3,230,000 tons, respectively, have been recorded. Sediment yields in the Walla Walla basin range from 420 tons per square mile per year from mountainous terrain to more than 4,000 tons per square mile per year from agricultural land.

On the west side of the Sacramento Valley southward to Antioch the average annual suspended-sediment yield of streams ranges from less than 100 to more than 3,000 tons

per square mile of basin area. These ephemeral streams transport large quantities of suspended sediment at high concentrations.

Most of the surface waters in lowland areas of the northern segment of the San Francisco leg are low in dissolved-solids content. Generally they contain less than 250 mg/l of dissolved solids, and commonly less than 100 mg/l; the greater concentrations prevail during periods of low flow, derived chiefly from groundwater.

In mountainous parts of the Pacific Northwest, surface waters generally have a dissolved-solids content of less than 100 mg/l. Small lakes with no surface outlet may have a dissolved-solids content from 1,000 mg/l to 70,000 mg/l or more, depending on the amount of water inflow and other factors. Local occurrences of bacteriological pollution occur along developed sections of the streams, usually during the summer when streamflow is low.

Along the pipeline route in California, stream quality, as in the Pit and Sacramento Rivers, is good to excellent. There dissolved solids, hardness, and turbidity are low.

In most streams along the route the dissolved-oxygen concentration is considerably more than the minimum essential for the maintenance of aquatic life. Some areas

of considerable dissolved-oxygen deficiency do occur but generally they are confined to short reaches of streams that receive oxygen-consuming wasters from industries and from cities.

In the Columbia-North Pacific Region which is traversed by the proposed pipeline alignment there are 829 public water supply facilities furnishing water to about 5 million people. The total water use for this purpose in 1960 was about 780 million gallons per day. Ninety percent of all these uses in the region was surface water and 10 percent groundwater. However, most of the public water supplies near the pipeline are from groundwater sources, with the exception of Walla Walla, Washington, which takes a reported 1.4 million gallons per year from Mill Creek, upstream from the proposed pipeline crossing.

In California some communities in the vicinity of the pipeline depend partly on local surface sources. Among these are Napa and Solano Counties, Sacramento (Sacramento River), Roseville, Fremont, Newark, and Marin County.

In the Rocky Mountain province groundwater of excellent quality is abundant and moves generally westward at the rate of about 1200 cfs in the deeper unconsolidated fill materials. Southward in the Columbia Plateau province

groundwater supplies in the underlying basalts are small and mostly untapped. Because the section is very sparsely settled along nearly all the pipeline route, present withdrawals are small and scattered. Locally, the water may be thermal.

South of the Oregon-California boundary, in the Cascade-Sierra Mountains, recharge to groundwater is potentially large, but few withdrawals are made of this excellent-quality water. In the fluvial plain of the Sacramento Valley the shallow groundwater is unconfined and little used. At depth the confined water is tapped by thousands of irrigation wells, 250 to 500 feet deep that commonly yield several hundred gallons per minute. Locally this has caused a lowering of the water table.

<u>West Coast (Los Angeles Leg)</u>

After originating at the international boundary the proposed pipeline continues in a southwesterly direction through Idaho, eastern Washington, Oregon, and Nevada to its terminal at Cajon, California. Since the first 206 miles of the Los Angeles route would parallel the San Francisco route described in the discussion above, that portion of the route

will not be repeated here. Crossings of 18 streams at 27 sites are planned, but no lakes or reservoirs are included. The principal rivers are the Moyie (8 crossings), Kootenai, Pend Oreille, Spokane, and Snake. In the Columbia River basin, maximum flows, usually from snowmelt, occur in May and June. Minimum flows generally occur in late summer. Many of the streams with headwaters in the mountains freeze or experience ice jamming during the winter, creating a flood potential. Intense winter rainstorms also occur in the area of the Walla Walla and Umatilla River Basins. Stream flow figures and flood recurrence figures for 50-, 100-, and 200-year intervals are found in Chapter 2, Part IV.

Southward throughout the northern and western Great Basin, mean annual runoff from the mountain areas is probably a fraction of an inch. Within Nevada the only channels crossed are desert washes, with the exception of two perennial streams, the Quinn and Humboldt Rivers, each of which derives most of its runoff from high ranges within the topographic province. Under rare conditions, flash floods can occur in the desert washes. South of the Humboldt River there is only one perennial stream, the Owens

River. Most of the water yield of the Owens Valley is exported to Los Angeles via aqueduct.

Sedimentation, dissolved-solids content and dissolved oxygen concentration for surface waters at the northern end of the proposed Los Angeles leg are discussed under the San Francisco heading above. South of the Humboldt River the waters of lower reaches of streams, especially playas (dry lakes), are usually saline due to high evaporation rates, and use is severely restricted.

Water supplies at the northern end of the Los Angeles route are discussed under the San Francisco heading above. While most municipalities along the northern part of the route rely on groundwater sources, Pendleton and La Grande, Oregon, draw on local surface water sources.

The dissolved-solids concentration of the groundwater varies widely from valley to valley. Most valleys have some groundwater with less than 400 parts per million of dissolved solids, but some have water with a dissolved-solids concentration of several thousand parts per million.

2.OV.6-7 Vegetation and Wildlife

Since biomes are as applicable to animals as they are to plants, and since the plants and animals in a biome are highly interdependent, vegetation and wildlife are discussed here together. This section identifies the most characteristic plant and animal species found in each of the major biomes crossed by the proposed route: tundra, northern coniferous forest, moist temperate coniferous forest, temperate grassland, temperate coniferous forest, desert, and chaparral. The moist temperate coniferous forest would be crossed only by two proposed alternative routes. This section also identifies sensitive or endangered plant and animal populations which may be affected by construction of the proposed gas pipeline. Specific treatment of vegetation and wildlife can be found in Chapter 2 of Parts II-V.

A. General Description

The proposed pipeline system will impact a wide array of plant and animal communities. A detailed discussion of all of these communities is not within the scope of this overview. It is possible to discuss the largest easily

recognizable terrestrial community unit, the biome, and to cover most of the types of plant and animal communities that will be encountered. Climate, substrate and the biota (plants and animals) interact to form this large unit.

In addition to the biomes there are broad ecotones (transition zones) between biomes which possess attributes of the biomes on either side. In areas of high topographic relief changes in biotic communities occur which are similar to those associated with changes in latitude. It would be too complex to treat all of the ecotonal or altitudinal variations in this discussion. Therefore, the discussion which follows is concerned only with the seven major community types (biomes) encountered along the routes being studied.

Tundra

The tundra is essentially a wet arctic grassland with the vegetation consisting primarily of lichens, grasses, sedges and dwarf shrubs. It is usually underlain by perennially frozen ground (permafrost). The frozen soil keeps the relatively small amount of available moisture

close to the surface. Low temperatures and a short growing season are the principal limiting factors to plant growth.

This vegetation would be encountered on the Arctic Slope, in the northern Mackenzie Valley and in discontinuous stands further south, particularly at high elevations.

The grazers on the tundra, though few in terms of species, are diverse--caribou, brown lemmings, ptarmigan and white fronted geese. Wolves and jaegers are the most prominent predators. Grizzly bears and arctic fox are the typical omnivores. During the short summer season water oriented birds such as waterfowl, shorebirds and divers are a dominant feature. A faunal element ignored by none is the one composed of biting flies and mosquitoes.

Alpine tundra types are somewhat different. Mountain sheep, ground squirrels, gyrfalcons and golden eagles are the most visible wildlife.

Northern Coniferous Forest

This biome stretches northwestward across Canada and Alaska as a broad belt, made even broader by the ecotones on either side, the subarctic forest and the aspen parkland. Along the prime route, this vegetative formation dominates

from the central Mackenzie Valley south to southern Alberta. It is also found in the lower 48 States at the northernmost end of the San Francisco and Los Angeles routes. In Alaska, it extends from the southern foothills of the Brooks Range south to Thompson Pass in the Chugach Mountains. Long fingers of this vegetation extend down the high spines of the western mountains in Canada and the United States. The dominant plant form is the needle-leaved conifer: spruce, pines and fir. Because of the acid litter on the forest floor, heath plants are common. Paper birch, balsam poplar, and aspen are common deciduous trees. The lichen <u>Cladonia</u> sp. still tends to be dominant on the forest floor. Twinflower, starflower, and dwarf cornel are common herbaceous plants. Bog and muskeg vegetation which can be found almost anywhere in this forest type draws on the same genera of plants found on the tundra.

Moose and varying hare are the characteristic browsers. Caribou continue to be important in the subarctic forest ecotone which comprises the interior forest in Alaska and a broad belt across northern Canada. The southern ecotones of this biome contain wapiti (American elk).

Closely tied to the hare is one of the more characteristic predators of the area, the lynx. The wolf is

still an important faunal component but the coyote has replaced it in many areas. Goshawks are an important predator component.

Fisher, marten, beaver, muskrat, otter and porcupine are prominent mammals. The grizzly bears are largely replaced by the black bear. Red-backed voles replace the lemmings. Red squirrels dominate in place of ground squirrels.

Ptarmigan are replaced by grouse of which the spruce grouse is the most typical biome inhabitant. Waterfowl are less prominent. Diving ducks are more common than the dabblers and sea ducks of the coastal tundra. Phalaropes give way to spotted sandpipers and lesser yellowlegs.

Gray jays, siskins, crossbills, Bohemian waxwings, chickadees and a variety of thrushes replace the lapland longspurs and snow buntings of the tundra. In the western mountains of Canada and the U.S., Clark's nutcracker and Townsend's solitare are found.

The biting Diptera (biting flies and mosquitoes) cannot be escaped in the forest; though the species have changed, the results remain the same. Bark beetles, budworms and sawflies are common insects.

Moist Temperate Coniferous Forest

The coniferous forest of the western coastal fringe of North America is quite distinct from the preceding biome. It is quite moist, deriving its moisture from high rainfall, coastal fog and persistent cloud cover. The seasonal temperature range is quite narrow. This vegetative formation is found along the coastal fringe of southeastern Alaska and would be encountered around Point Gravina and Haines in two of the proposed alternative routes.

The sitka spruce and western hemlock are characteristic species of the forest canopy. Along streams the black cottonwood is dominant. Mosses cover the forest floor, along with downed timber and tree limbs. Sitka alder, devils club, bluejoint, and ferns dominate the unforested hillside openings. Blueberries, copperbrush, Labrador tea, and salmonberry fill the open spaces on the forest floor. Skunk cabbage, one-flowered wintergreen, fireweed and ferns are common.

Black bear and brown bear are the dominant mammals in this forest. Mountain goats occupy the areas above the forest. Sitka black-tailed deer have been introduced to the Prince William Sound portion of this forest. Wolves, wolverines, red fox, lynx, marten and red squirrels are

other important species. Sea otters and sea lions frequent the inshore marine waters.

Stellar's jays, Canada geese, trumpeter swans, bald eagles, rufous hummingbirds, varied thrushes, Townsend's warbler, siskins and chestnut backed chickadees are found in the forest or associated with wetlands in the forest. Golden eagles and marbled murrelets nest above the trees. Black-legged kittiwakes, pelagic cormorants and pigeon guillemots nest on the rocky headlands fronting the sea. Black oystercatchers, rock sandpipers, surfbirds and black turnstones inhabit the shore area.

The streams are filled at spawning time by pink, chum and red salmon, cutthroat trout and Dolly Varden. Rocky reefs and kelp beds just offshore harbor rockfishes, greenling and lingcod.

Temperate Grassland

The temperate grasslands have in common the grass lifeform, a precipitation level that is too low to support forests and too high for true desert. Along the proposed route, this vegetative formation is encountered between southern Alberta and the Mississippi River and at scattered

locations in the western United States. The species composition varies widely. The northern grassland has three zones from west to east which are described on the basis of the height of the most characteristic grasses. The short grass zone is best described by blue grama and buffalo grass. Little bluestem, green needlegrass, sand dropseed, and western wheat grass are typical of the mid grass prairie. Tall grass prairie grows big bluestem, switchgrass and Indian grass. California grasslands support other grass species.

Grasslands have been much altered by overgrazing, conversion to croplands and erosion in drought years. The fauna of the grasslands has changed also. The pronghorn is the principal large grazer still remaining. Jackrabbits (white-tailed in the north and black-tailed in the south), white-tailed prairie dogs, and a variety of other rodents round out the herbivores.

Badgers, striped skunks, raccoons, coyotes, and red fox are common predators along with burrowing owls, Swainson's hawks and prairie falcons.

Prairie chickens, Franklin's gulls, Forester's terns, Say's phoebes, lark buntings, Western meadowlarks, chestnut-collared longspurs and vesper sparrows are typical bird

species. Waterfowl and shorebirds are very common in the pothole regions.

Temperate Deciduous Forest

Deciduous forests occur where there is plentiful rainfall (30-60 inches), moderate temperatures and a distinct seasonal cycle. This forest once covered most of eastern North America, but has been much modified by man's activity, and so has its fauna. Now patches of the temperate deciduous forest are found along the eastern part of the proposed Northern Border route.

Within the deciduous forest are a variety of climax types including the maple-basswood forest, beech-maple forest, oak-hickory forest and the oak-chestnut forest.

The white-tailed deer and black bear are characteristic large animals. Gray fox and red fox are characteristic predators. Gray squirrels, southern flying squirrels, eastern chipmunks, and a variety of small rodents also occur in the deciduous forest.

The red-shouldered and broad-winged hawks are common raptors. Bobwhites, wood ducks, American woodcocks and

mourning doves are typical gamebirds. There is a great variety of perching birds.

There is a great variety of fish, frogs, salamanders, snakes, turtles and insects. Because the deciduous forest is so broken up, there is often only a poorly discernible pattern in the distribution of many species. Some animals are there because of what the historical vegetation was and some are there because of the current land use.

Desert

Deserts occur in areas where annual rainfall is less than 10 inches or where the rainfall is very unevenly distributed. The proposed San Francisco route crosses desert in the vicinity of the Columbia River, and the proposed Los Angeles route traverses desert from southeastern Oregon to its terminus near Los Angeles. American deserts are the result of their geographical position in the rain shadow of western mountain ranges. Three plant life-forms are adapted to desert living: annuals, succulents and desert shrubs. Perennial grasses and forbs can maintain themselves in many areas.

The North American deserts can be divided into cold deserts and hot deserts. Sage brush, greasewood, shadscale, and saltbrush are characteristic plants of the cold deserts. Creosote bush, yucca, and cactus are more typical of the hot desert.

Reptiles and insects are well adapted for desert life. Mammals and birds are able to exist because of local modifications such as streams, springs and seeps. The best adapted mammals are the kangaroo rat and pocket mouse.

The ferruginous hawk is the most typical bird of the cold desert. Great horned owls, prairie falcons and golden eagles are locally common raptors. Mule deer, pronghorn antelope, kit fox and bobcat are the most common larger mammals.

In the hot desert (Mojave Desert) the long-tailed and little pocket mice are characteristic mammals. Other mammals are Merriam's kangaroo rats, antelope ground squirrel, kit foxes, coyotes, and spotted skunks. Typical birds are Gambel's quails, roadrunners, sage sparrows, mourning doves, and phainopeplos.

Reptiles flourish and the desert iguanas, sidewinder rattlesnakes and desert tortoises are most abundant in this

habitat. Long-nosed leopard lizards, desert side-blotched lizards and checkered whiptails also occur.

Chaparral

The chaparral is probably partly a fire-maintained disclimax. A disclimax is a relatively stable ecological community that has displaced the climax community in an area, usually as a result of externally-caused disturbance. The chaparral is essentially a shrub forest; along the proposed route, it would be encountered primarily in California. A variety of aromatic shrubs, summer deciduous shrubs and evergreen oaks provide the canopy cover. The growing (rainy) season extends from November to May. Mule deer and a variety of birds occupy the chaparral at that time. Bush rabbits, wood rats, chipmunks, wren-tits, brown towhees and a variety of lizards are typical resident species.

B. Sensitive Populations

The primary route of the pipeline proposed by the Alaskan Arctic Gas Pipeline Company would cross the Arctic

National Wildlife Range. In doing so it would cut across an essentially undisturbed continuum of Arctic Coast, Arctic Coastal Plain, Northern Foothills and the Brooks Range. It is the essence of wildness to many people even though they may never see it. The portion of the range flanking the prime route is the calving area of the last essentially untouched great caribou herd, an international herd ranging across Alaska, the Yukon and the Northwest Territories.

The prime route would cross a fall staging area for migrating snowgeese. A coastal alternative would pass through a major molting area for Arctic waterfowl. The route would cross Alaska's major shore polar bear denning area.

Arctic fish populations are characterized by a low recruitment rate, slow growth, great age at maturity, and a large percentage of individuals of older age classes. These populations cannot sustain heavy fishing pressure without serious impact on their reproductive potential.

Fish species diversity is low (15 species) in the Arctic Slope streams draining into the Beaufort Sea. Grayling and Arctic char are important components of the fauna. The prime source of construction gravels on the Arctic Slope is in the braided channels of the larger streams. The only

alternative source, which is not adequate, is from ice-free upland sites. These sites are valuable as denning sites for Arctic foxes, grizzly bears, wolves and ground squirrels. They also offer the wind shelter which is essential to maintenance of butterfly populations in the Arctic.

The vegetation on the Arctic Coastal Plain and the Arctic Slope is extremely important in terms of its insulative value. In its undisturbed state it plays a prime role in maintaining the thermal balance in the ice-rich soils. Once this balance is disturbed it requires a great amount of time to achieve a new equilibrium.

It is essential that disturbed vegetation be restored or replaced as quickly as possible. There are no seed sources for native vegetation so temperate species would be used. If carefully selected these would flourish at first but because they are poorly adapted to the Arctic they would die out in a relatively short span of time. Replacement by native species would be slow. Seed set among native plants is unreliable. Vegetative reproduction is common and viviparity (when the seed germinates on the plant) is by no means rare. The transplanting of native plants and shrub cuttings into seeded areas might provide the greatest long-term effectiveness.

In the northern Mackenzie Valley, the proposed Canadian Arctic Gas pipeline would pass through the wintering range of the Porcupine Caribou herd. The bane of Arctic animals is improved human access. Other animals besides caribou would be affected. These include, in addition to the Dall sheep in the Richardson Mountains, wolves, grizzly bears and a number of small predators and furbearers.

Species diversity of fish in the Mackenzie Drainage, the second largest in North America, is much greater (34 species north of 60°N) than in the Arctic Slope drainages. The larger the stream the greater the diversity. Arctic grayling and northern pike are apparently the most widely distributed species. South of 60°N in the Peace and Athabaska Rivers a number of new salmonids are encountered. Ice-rich soils and their associated erosion problems are encountered as far south as the confluence of the Liard and Mackenzie Rivers. The resulting increased sediment load in streams draining the proposed route would be particularly critical for species requiring clear water.

The prime route generally stays well north of critical raptor nesting areas within Alaska. The alternative route around the Arctic National Wildlife Range would pass through areas with relatively large numbers of breeding peregrine

falcons, gyrfalcons and golden eagles. In the Mackenzie Valley north of 60°N there are a number of areas where raptor eyries can be found within a corridor extending 10 miles on either side of the proposed right-of-way. These include the coastal area between the Mackenzie River and the Alaska Border, the Mackenzie River Delta; and the interior mountains. Peregrine falcons of 2 endangered races, gyrfalcons, golden eagles and bald eagles occur within suitable habitats.

South of 60°N the proposed route begins to enter less sensitive country. Permafrost problems are behind. Fish populations are less sensitive. The pipeline would be buried and the route revegetated quickly.

The proposed North Border Pipeline would cross a number of fee title and easement Waterfowl Production Areas in the pothole region of the Great Plains (principally in South Dakota and Minnesota). Class I, II, and III pothole habitat areas on these and on private lands would be vulnerable to disruption by pipeline construction activities. These areas are valuable to a large variety of waterfowl and other wildlife.

The proposed Northern Border Pipeline would cross natural plant communities only along about 23.3 percent of

its route. The greatest potential impacts along this route are generally related to the loss of additional habitat.

Sensitive populations and/or habitats have been identified along the route. The Indiana bat which ranges along the proposed route in Illinois, Indiana, Ohio, West Virginia and Pennsylvania is an endangered species. One piece of critical habitat for this species is an abandoned mine within 1,000 feet of the proposed route in Illinois. Along Pecumsaugan Creek in the same general area the route would pass an area unique for this locality, containing a community of white pine, arborvitae, a rare grass Muhlerbergia cuspidata and the timber rattlesnake. Big Darby Creek, a tributary of the Scioto River in Ohio, contains a madtom (catfish) Noturus trautmani and 4 molluscs being considered for inclusion on the national list of endangered species. The tubercled-blossom pearly mussel of the Ohio River, the pink mucket pearly mussel of the Muskingum River and the Higgins Eye pearly mussel of the Mississippi River occur in areas crossed by the route and all have been proposed for inclusion on the Federal list of endangered species. Many of the States have their own endangered species list for species endangered with a State but not endangered nationally.

Desert vegetation, which is very sensitive to disturbance, has a highly characteristic spaced distribution. What appears to be bare ground between the scattered plants may not be truly bare. Mosses, algae and lichens often occupy this open space, stabilizing the crust and providing fixed nitrogen. During seasonal or sporadic periods of relatively higher moisture, annual plants often appear in profusion. The desert vegetation, like the arctic vegetation, takes decades to restore once it is disturbed. The disturbance of the crust leaves the area open to accelerated wind erosion.

The wildlife along the three routes that would enter the desert areas is most vulnerable to pipeline-related effects through impacts on habitat. A relatively large number of desert plants and animals appear on State and Federal endangered species lists because of serious encroachments on their habitats. Most of the land over which these pipelines would cross has been heavily impacted by man's use since the early nineteenth century. In the 8 California counties that would be crossed by the San Francisco pipeline the number of rare, endangered or extinct plants on the California Native Plant Society list ranges from 2 to 30.

The chaparral vegetation is extremely vulnerable to fire during the dry summer season. This is in keeping with the high degree of probability that this vegetation is a fire-maintained disclimax.

It is not readily apparent how many endangered species could be impacted by construction of this proposed project. Conservatively, 1 fish, 1 reptile, 12 mammals and 7 birds could become involved with one or more phases of the proposed action or its alternatives.

The animals in the vicinity of the proposed route which are presently on the Federal list of endangered species are shown in Table 2.OV.6-1. There are other biological taxa which are rare, threatened or endangered; preliminary legal steps are being taken to arrive at formal Federal lists of endangered plants and butterflies. These Federal lists presently do not exist, however. The scope of the problem can be seen in the Smithsonian Institution's list of 3,000 rare and threatened plants for the 50 States. Undoubtedly, a large number of these would be encountered by this project. Until the exact location of the pipeline is established, it is impossible to determine which endangered species will actually be crossed by the pipeline.

Table 2.OV.6-1
Endangered Species
Along Proposed Route

	Alaska	Canada	Northern Border	Los Angeles	San Francisco
Fishes					
Owens River Pupfish				X	
Reptiles					
Blunt-nosed Leopard Lizard				X	
Birds					
Short-tailed Albatross					
Brown Pelican					
Aleutian Canada Goose					X
California Condor				X	
Southern Bald Eagle					
American Peregrine Falcon	X	X	X	X	X
Arctic Peregrine Falcon	X	X			
Eskimo Curlew		X			
California Least Tern					
Mammals					
Indiana Bat			X		
Blue Whale					
Bowhead Whale	X	X			
Finback Whale					
Humpback Whale					
Pacific Right Whale	X	X			
Sei Whale					
Sperm Whale					
Gray Whale	X	X			
Black-footed Ferret			X		
San Joaquin Kit Fox				X	
Northern Rocky Mountain Wolf				X	X

2.OV.8 Ecological Considerations

In this environmental impact statement the discussion has been approached on a topical basis. Ecological coverage can be found in the topical discussion on vegetation, wildlife, soils, climate, water and permafrost. One ecological concern has not been discussed elsewhere, however. This relates to the controversy over the "fragility" or stability of high latitude ecosystems. It is beginning to appear that these ecosystems while unstable or fragile locally can be stable if their spatial scale is large enough.

One of the most tenacious of all of the fundamental tenets of ecology is the one that holds that stability is the result of diversity. High latitude ecosystems lack species diversity, usually have very short food chains and exhibit extreme oscillations in populations of constituent species. From the classic viewpoint the result is instability and fragility. If the arctic tundra is unstable because it is subject to severe oscillations, how is it that the system as a whole survives?

Stability is the ability of a system to recover from a disturbance or a series of disturbances. There are two basic concepts of stability, local stability and global

stability (Krebs, 1972). Local stability is the ability of a system to return to its original condition after slight disturbance. Global stability is the ability of a system to return to its original condition after major disturbances.

Apparently the arctic tundra exhibits local instability and a high degree of global stability. Dunbar (1973) sees reason for the global stability in the very large spatial scale of the ecosystem. This large spatial scale provides for mending or reestablishment in the face of local stresses or perturbations.

Along with large spatial scale, time is important to the maintenance of high latitude ecosystems. For example, the price of the low metabolic rate essential for life in arctic waters is a very slow rate of growth and a greatly extended period of maturation. This slow rate of growth dictates the extreme vulnerability of arctic fish to man's interference.

Dunbar (1973) redefines stability to include the high latitude situation. In this type of stability he sees an ability in the system to absorb serious perturbation and return to a stable state. In a highly oscillating physical environment the stable biotic environment is the one which can respond with its own oscillations, in other words roll

with the punches. Very large spatial scale and adequate time for repair are essential for this type of stability.

The serious threat at this time lies not in developing the Arctic but in committing it all at once and not allowing time for natural repair. If we are going to allow development it is essential that large ecosystem reservoirs be held in reserve so that the spatial scale requirement can be met. It is also essential that we schedule development so that one area has recovered sufficiently to sustain the healing process before we commit another area.

The present course of development on the Arctic Coastal Plain is fraught with hazard simply because there is no plan. The central part of the coastal plain between the Colville River on the west and the Canning River on the east is State land and management of this section is fully committed to development of the oil and gas potential. Federal reservations lie on either side of this central section, the Arctic National Wildlife Range on the east between the Canning River and the Canadian boundary, and Naval Petroleum Reserve No. 4 on the west between the Colville River and the 162° meridian. The first area is relatively undeveloped and the second is recovering from earlier oil exploration activity.

These two areas would provide ecological reservoirs on sufficient spatial scale to make possible repair of unavoidable disturbance within the Prudhoe Bay development area and access corridors. The Federal government is considering committing both of these reservations to development in response to the pressure of the current "energy crisis." Coordination of these actions would permit a simultaneous examination of the ecological consequences of developing the entire coastal plain in the context of the spatial and temporal factors inherent in the preceding definition of stability. Clearly a weighting of all factors in this context is in order before decisions are made committing either Federal reservation.

2.OV.9 Economic Factors

This section contains information on the history of economic development, principal economic activities today, employment and income, the local tax structure and base, and future economic trends. Along the pipeline route, one finds great differences in economic activities and conditions, especially in comparing the Alaskan and Canadian Arctic with the Canadian provinces and the lower 48 States. There is a trend toward economic development and expansion of the wage economy occurring in the Alaskan and Canadian Arctic, especially as a result of mineral exploration and development. In the Canadian provinces and the lower 48 States, major changes in the types and levels of economic activity are not seen.

Regarding employment and income, unemployment, especially among Natives, has been very high along the portions of Northern Alaska, the Yukon Territory, and the Northwest Territories to be crossed by the proposed route. Personal income is low and most Natives engage at least part-time in subsistence hunting and fishing; in the Mackenzie-Northern Yukon study region, estimated cash personal income (term not defined in the Applicant's study report) was $2,100 in 1971. Along the Northern Border

route, unemployment has been around or above the national average at the eastern and western ends, and below the national average along the remainder of the route; only seven of the seventy-six counties along that route had per capita incomes above the national average of $4,500 in 1972. For the two West Coast legs of the pipeline, unemployment varied from over 9 percent in nine counties to under 4 percent in eight counties in 1969. Most counties in Idaho and Oregon had per capita incomes clearly below the national average, while counties along the route in Southern California were generally above the national average.

In the North Slope Borough of Alaska and in the States and their subdivisions along the pipeline route, there is heavy reliance on the property tax for revenue. The North Slope Borough also taxes oil and gas production, and the State of Alaska will receive large royalties when oil production begins.

A. History of Economic Development

Alaskan history has been one of succeeding booms and busts. Previous booms have been based upon fur, gold, copper, and fish. A timber boom occurred in the 1950's

while an oil boom began in 1957 and became important by 1969. Defense became an important industry in 1942 and has since peaked and declined.

Anchorage has become a manufacturing and service center for the entire State while Fairbanks has become a commercial and trade center for the central and northern portions of the State.

In the North Slope Borough, which is essentially the portion of Alaska north of the Arctic Circle, coastal towns served the whaling industry in the 19th century, and more recently have provided the Distant Early Warning System sites with supporting services. The subsistence hunting and fishing economy has always been important, and remains important to the economy of the North Slope Borough. The subsistence economy consists of living off the land without working for wages.

The fur trade was established in the Northwest Territories of Canada in 1789, which at that time included Alberta and Saskatchewan. Furs were traded to Natives of eastern Alaska who in turn traded them to the Russians. After 1840, furs traveled east because the Hudson Bay Company provided a preferable market. The fur trade boom became a bust in the 1930's because of the Depression.

Northern coastal towns served the whaling industry until 1912. In 1896, the famous Yukon gold rush yielded a classic boom and bust. In 1919, oil development began in the Northwest Territories. The DEW-line has provided employment since the 1950's and a wage economy has been established in the 1960's although subsistence hunting and fishing remains very important.

In Alberta, fur trading was succeeded by agriculture, mining and manufacturing after rail transportation became available in the 1880's.

Along the route of the Northern Border pipeline, the intensity of economic activity increases from northwest to southeast. In our descriptions of this area we divide it into three basic regions: the Western Grazing and Wheat Area (Montana to South Dakota), the Corn Belt (Minnesota to western Illinois), and the Great Lakes Manufacturing Belt (eastern Illinois to Pennsylvania).

Pittsburgh was established in the mid 18th century, and was by 1800 an important industrial and commercial center. Since the 19th century it has been an important steel manufacturing center because of its proximity to local coal and a waterway for transporting Minnesota iron ore. The States of Ohio, Indiana, and Illinois experienced rapid

agricultural settlement and early industrialization because the Ohio River, Great Lakes, and Erie Canal provided easy access to markets. After 1850 railroads expanded to serve this area and industrialization intensified.

In the Corn Belt, the extension of railroads across the Mississippi River improved access to eastern markets and speeded development after 1850. In the Western Grazing and Wheat Area, fur traders dominated until the 1870's when large cattle herds were established. Dry land farming followed and irrigation eventually increased agricultural productivity.

California was settled by the Spanish and developed its own initially agricultural economy. The rigors of traveling across the continent in covered wagons or sailing around Cape Horn did not prevent settlers from coming to California for the Gold Rush of 1849 or settling California and the Pacific Northwest. However, it was not until completion of the transcontinental railroad that the California economy really began to be integrated into the U. S. economy.

B. Principal Economic Activities

In Alaska, commercial fishing has been important since the late 1800's. The catch is high value salmon and shellfish, making Alaska the most important State in terms of value of fish caught. Fish processing, timber, and tourism are also important. Petroleum exploration, production, and minor refining also take place. Construction is important; however, much of this is the result of the building of the Trans-Alaska Pipeline System (TAPS) and construction may decline after its completion.

In the North Slope Borough, the important economic activities center around subsistence hunting and fishing, the DEW-line, tourist services, and petroleum exploration and development. Subsistence hunting and fishing are important because they permit people to survive and maintain traditional forms of life, while the DEW-line, petroleum industry, and tourism provide wage employment directly or indirectly.

In the Northwest and Yukon Territories, subsistence hunting and fishing, fur trapping, commercial fishing, logging, and mineral exploration and production are important economic activities. In the provinces (Alberta, British Columbia, and Saskatchewan), manufacturing,

construction, agriculture, and commercial services are important. In British Columbia, fishing is also important, and in Alberta, mining is very important, since Alberta produces most of Canada's fossil fuels and over 25 percent of her minerals. Provincial agriculture is heavily spring wheat.

Along the Northern Border route, the Western Grazing and Wheat Area produces spring wheat and range cattle, and also hay, flax, oats, barley, rye and sheep. There is coal production in Oliver and Mercer Counties in North Dakota, and some oil in MacKenzie and Williams Counties in North Dakota and Roosevelt County, Montana. Farm related manufacturing and recreation are found in many small towns which also provide commercial services to neighboring farmers.

In the Corn Belt almost the entire land mass is planted in crops; principal farm products include corn-fed cattle and hogs, corn and soybeans. Eastern Iowa and western Illinois also have heavily industrialized zones which produce many types of farm machinery and have a wide range of other heavy and light industries.

The Great Lakes Manufacturing Belt is a highly urbanized industrialized zone containing 24 SMSA's; between eastern

Illinois and western Ohio, it also contains some of the most productive agricultural land in the world. Farm products include corn, soybeans, and wheat. Manufactured products include food, steel and many other products. This area has an even more intense concentration of heavy and light industry than the eastern Corn Belt. In eastern Ohio, western Pennsylvania, and Brook County, West Virginia, small farms produce mainly for local markets and coal is mined. The coal is used for steel making in Pittsburgh and Wheeling.

The important crops along the routes crossed by the two West Coast legs may be summarized by State as follows:

States	Crops
Idaho	hay, wheat, and grains
Washington	wheat and hay
Oregon	wheat, hay, grains and potatoes
Nevada	hay
California	hay, orchards, and grains

The Idaho counties to be crossed also produce lumber, livestock, and dairy products. Besides the crops above, the States along the remainder of the San Francisco leg produce mainly livestock and forest products. Other main areas of economic activity in States along the remainder of the Los Angeles leg are manufacturing, livestock, trade and government.

C. Employment and Income

In Alaska, 42 percent of the state work force works for government. Unemployment is typically twice the national average, with seasonal rates for Natives often reaching 90 percent. Economic activity increased in 1974, but so did the unemployment rate, reflecting immigration. Alaska's economy is undergoing drastic change because of the Trans-Alaska Pipeline System construction project. At the peak levels of activity, approximately one in five jobs in Alaska will be directly or indirectly resulting from TAPS. Fairbanks is the location of 75 percent of the northern work force. In 1972, the northern work force totaled 26,100. The state work force was 162,400 persons in 1973 and 158,100 in 1972.

Much income is non-work related. Natives receive substantial sums from the Alaska Native Claims Settlement Act (ANCSA) and many residents, especially Natives, receive Federal transfer payments such as Aid for Dependent Children, Bureau of Indian Affairs programs, food stamps, and Rural Electrification Act subsidies. As a result of ANCSA, Alaska Natives will receive 40 million acres of land, including both surface and subsurface rights, and $962.5 million over an 11 year period.

In the northern areas of Alaska and the Yukon and Northwest Territories, important sources of income include subsistence hunting and fishing and working at the DEW-line stations.

In the Northwest Territories and Yukon Territory, unemployment is high and what employment there is is concentrated in government and services. In the Mackenzie and Northern Yukon study region, the work force was 13,239 in 1971. Estimated cash personal income in the study region was $2,100. This included earned income and transfers (welfare, unemployment, housing subsidies, etc.), but not income in kind such as could be earned in the subsistence economy.

Along the route of the Northern Border pipeline, unemployment rates varied from above the national average in Montana to about the national average in North Dakota, eastern Ohio and western Pennsylvania, and below the national average along the remainder of the route. Only 7 of 76 counties had per capita income above the national average of $4,500 in 1972, but the 7 counties' populations were so high that the average per capita income of the 76 pipeline counties was equal to the national average. The range in per capita incomes in 1972 was from $3,195 (71

percent of the national average) in South Dakota pipeline counties to $4,897 (109 percent of the national average) in Illinois pipeline counties.

For counties along the proposed West Coast legs, there were strong variations in per capita income and unemployment rates. Unemployment was high (over 9 percent) in Idaho; Columbia County, Washington; Union and Baker Counties, Oregon; and Siskiyou, Shasta, and Tehama Counties, California. It was low (under 4 percent) in Whitman County, Washington; Gilliam and Sherman Counties, Oregon; Humboldt, Lander, Nye and Mineral Counties, Nevada; and Colusa County, California.

In California, San Bernardino County has 133 percent of the national average per capital income; Contra Costa County had 127 percent, and Inyo County had 117 percent. In Nevada, Lander County had 85 percent and Nye County had 123 percent. In Idaho, Bonner and Boundary Counties had 79 percent. In Oregon, Malheur County had 76 percent, Baker County had 83 percent, and Gilliam, Sherman and Jefferson Counties had 84 percent. These were the extremes. Idaho and Oregon counties were clearly below the national per capita income average, while southern California counties were generally above.

D. Local Tax Structure and Base

In 1973, Alaskan state revenue was $369 million. The principal sources were excise taxes ($84 million), income from investments ($43 million), and Federal receipts ($137 million). The heavy dependence upon income from investments and Federal receipts is unique among the States. Alaska has been running heavy deficits since the sale of the Prudhoe Bay leases because it has increased government expenditures greatly in anticipation of large scale oil production and the State revenue it will bring. When oil is being produced at 2 billion barrels/day, Alaska will collect a royalty of $150 million per barrel of wellhead value. At $7/barrel, this would be $1,050 million/year. The proposed budget for Fiscal Year 1974 was $491 million. Because revenues will only be $448.5 million, there will be a deficit of $42.5 million.

The budget for the North Slope Borough for Fiscal Year 1973-74 was $5 million, and is proposed to increase to $9 million for Fiscal Year 1974-75. Principal sources of revenue are taxes on oil and gas, property taxes and State impact funds.

In the Northwest and Yukon Territories, the Canadian Federal government is authorized to tax income and game.

Northwest Territories tax revenue for 1971-72 was $16 million, which was only 21 percent of expenditures, with the Canadian Federal Government providing the balance. Expenditures have grown rapidly from $3 million in 1959-69 to $41 million in 1969-70 and $91 million in 1971-72. No municipal taxes are collected in most small communities.

Along the Northern Border, San Francisco, and Los Angeles routes a maze of intricate overlapping taxing authorities, including townships, counties, States, school and sewer districts is found. The major local expenditures are for schools and roads. Heavy reliance is placed upon the property tax as a revenue source.

Reliance of State and local governments upon the property tax in the States along the Northern Border route is shown in Table 2.OV.9-1.

Reliance upon property taxes is also heavy in the counties crossed by the proposed San Francisco and Los Angeles routes, as shown in Table 2.OV.9-2.

E. Future Economic Trends

In Alaska, there will be a general expansion of the economy because of construction of the Trans-Alaska Pipeline

Table 2.OV.9-1
Revenue Sources in States Along Proposed Northern Border Route

State	State & Local Taxes (000,000)	Property Taxes (000,000)	%
Montana	367	185	50
North Dakota	272	112	41
South Dakota	313	168	54
Minnesota	2,252	904	40
Iowa	1,458	659	45
Illinois	6,472	2,662	41
Indiana	2,350	1,163	49
Ohio	4,516	1,944	43
West Virginia	697	145	21
Pennsylvania	6,272	1,731	28

Table 2.OV.9-2
Revenue Sources in Counties Along Proposed
San Francisco and Los Angeles Routes

County	Local Government Revenues (000,000)	Property Taxes (000,000)	%
Boundary, Id.	$ 2.5	1.1	44
Bonner, Id.	3.2	1.9	60
Kootenai, Id.	6.6	2.8	43
Spokane, Wash.	67.3	22.2	33
Columbia, Wash.	1.8	.5	28
Whitman, Wash.	8.4	2.6	31
Walla Walla, Wash.	10.8	4.1	38
Umatilla, Or.	15.2	7.8	51
Crook, Or.	3.1	1.5	48
Deschutes, Or.	9.2	4.2	46
Gilliam, Or.	1.2	0.6	50
Jefferson, Or.	3.6	1.9	53
Klamath, Or.	14.2	6.9	49
Morrow, Or.	2.4	1.3	54
Sherman, Or.	1.2	0.6	50
Wasco, Or.	6.9	3.6	52
Baker, Or.	4.8	2.6	54
Malheur, Or.	7.8	3.7	47
Union, Or.	4.5	2.7	60
Churchill, Nev.	5.2	1.5	29
Esmeralda, Nev.	.25	.12	48
Humboldt, Nev.	2.7	1.0	37
Lander, Nev.	.9	.4	44
Mineral, Nev.	2.1	.45	21
Nye, Nev.	2.2	.9	41
Pershing, Nev.	1.6	.7	44
Yolo, Ca.	32.7	15.9	49
Tehama, Ca.	12.6	5.5	44
Solano, Ca.	62.6	21.3	34
Siskiyou, Ca.	16.9	6.2	37
Shasta, Ca.	41.0	15.7	38
Sacramento, Ca.	277.4	108.1	39
Modoc, Ca.	4.3	1.5	35
Glenn, Ca.	9.9	4.1	41
Contra Costa, Ca.	252.7	124.3	49
Colusa, Ca.	9.7	4.6	47
Inyo, Ca.	8.8	3.6	41
San Bernardino, Ca.	277.7	118.7	43

System. After construction, the economic base will contract, but this contracted level will constitute a much higher base than currently exists. Further growth can be expected from increased mineral exploration and development on the North Slope, especially petroleum and natural gas. There will be a decreased dependence upon government, and strong expansion of forestry, tourism and other commercial services. Expansion is not expected for commercial fishing or fish processing, and subsistence hunting and fishing is expected to decline.

The Northwest and Yukon Territories have a strong trend toward economic development and expansion of the wage economy. Continued exploration for and development of petroleum and natural gas and other minerals will help to fuel this expansion. Trapping and subsistence hunting and fishing will decline while logging and commercial fishing should remain stable.

Major changes are not expected in the economies of the counties in the lower 48 States or the Canadian provinces where pipelines are proposed except that a coal gasification industry may well develop in Mercer and Oliver Counties in North Dakota.

The Western Grazing and Wheat Area will continue to produce agricultural products and coal. Coal production is expected to expand greatly through the year 2000, while oil production will contract as wells are depleted. No great change is expected in the small manufacturing sector, although some expansion can be expected in recreation. In the Corn Belt and the Great Lakes Manufacturing Belt continued emphasis on manufacturing and agriculture is expected without much change. Continued emphasis upon small farms and coal mining is expected in the eastern Great Lakes Manufacturing Belt.

In West Coast pipeline counties, continued emphasis upon agriculture, light industry, and services can be expected. Economic growth will be most pronounced in Reno and Las Vegas and in the California counties of Sacramento, Contra Costa, and San Bernardino.

2.OV.10 Sociological Factors

This section contains information on populations, area population trends, forms of government, educational attainment levels, health services, and housing conditions found along the proposed route.

A. Population

Total population along the proposed pipeline route, based on 1970 U.S. Census data (1971 data from Canada) is shown in Table 2.OV.10-1.

Alaskan population, as shown in Table 2.OV.10-2, has been growing rapidly since 1940 as a result of immigration. This has raised the non-Native percentage of the Alaskan population from 55 percent in 1940 to 77 percent in 1960 and 78 percent in 1970.

Table 2.OV.10-1
Total Population Along Proposed Route

Kaktovik and Prudhoe Bay - Deadhorse, Alaska	302,173
Yukon-Northwest Territories, Canada*	23,662
Alberta Province, Canada	1,600,000
East Kootenay District, British Columbia, Canada	39,700
Southwestern Saskatchewan, Canada (20 mile corridor)	9,000
Northern Border Route Counties	4,732,400
San Francisco and Los Angeles Route Counties	2,779,651
Total	9,506,586

*Applicant's Study Area Only

Table 2.OV.10-2

Alaska Population 1940-1970

Year	Total	Non-Native
1940	72,524	39,566
1960	226,107	174,546
1970	302,173	236,767

Over 50 percent of Alaska's population lives in the Anchorage and Fairbanks metropolitan areas and much of the State is unpopulated. It is a young population with a median age of 20 for non-Natives and 18 for Natives (persons of at least 25 percent indigenous lineage).

The North Slope Borough is mainly (82 percent) inhabited by inland Eskimos (Nunamiut) and maritime Eskimos (Taremiut). In 1970 estimated borough population was 3,385. Deadhorse-Prudhoe Bay and Kaktovik are the only inhabited areas near the proposed pipeline. Deadhorse-Prudhoe Bay has a combined population of 212 which is primarily Caucasian while Kaktovik has a population of 123 which is primarily Eskimo. Natives are tending to migrate to established communities, such as Barrow, in search of wage employment.

In the Northwest Territories, population has grown from 6,507 in 1911 to 34,805 in 1971. Of this, 23,662 or 68 percent live in the study area. Of this 23,662, 7 percent

are Inuit (Eskimo), 26 percent are treaty Indians (Indians who have individually signed agreements with the Canadian governments, thereby gaining certain rights), and 67 percent are non-treaty Indians, Metis (persons of mixed blood) and whites.

In Alberta there are only 30,000 native Indians among a population of 1.6 million. Half live in Edmonton (total population, 438,152) and Calgary (total population, 403,319) which are the only major population centers. In British Columbia, the East Kootenay district through which the pipeline is proposed to run has a population of 39,700. Approximately 9,000 people live within 10 miles of the proposed route in southwestern Saskatchewan.

The route of the Northern Border pipeline was settled from east to west. Western Pennsylvania was settled by 1800 and Montana by 1900. The Western Grazing and Wheat Area population has peaked and begun declining, while the more urban Corn Belt and Great Lakes Manufacturing Belt areas are still growing. The population of the 76 counties along the Northern Border route was 4,732,400 in 1970. Four percent live in the Western Grazing and Wheat Area, 26 percent in the Corn Belt, and 69 percent in the Great Lakes Manufacturing Belt.

Population figures for 1960 and 1970 for the counties to be crossed by the two West Coast legs of the pipeline are shown in Table 2.OV.10-3. We may conclude that Idaho, Washington, and Oregon counties have had stable populations between 1960 and 1970, while Northern California and Nevada have experienced moderate growth and the San Francisco area and Southern California have experienced strong growth.

B. Area Population Trends Without Pipeline Construction

The population of Alaska is expected to grow from 302,200 in 1970 to 419,800 in 1980, an increase of 38.9%.

In the study area of the Yukon and Northwest Territories, working age population is expected to increase from 13,549 in 1971 to 20,938 in 1981, an increase of 54.5%.

In the lower 48 States, projections by economic area are available from the U.S. Bureau of Economic Analysis. Figure 2.OV.10-1 shows the location of each economic area. The areas shown in Table 2.OV.10-4 are those containing pipeline counties; each area is named after the largest SMSA, or if none, the largest city it contains.

Along the proposed route, high population growth may be expected in the Yukon and Northwest Territories, Alaska,

Table 2.OV.10-3
Population of Counties Along San Francisco and Los Angeles Routes

	1960	1970	Percent Change
Idaho (Boundary, Bonner, Kootenai)	50,952	56,376	+10.6%
Washington (Spokane, Whitman, Columbia, Walla Walla)	356,327	372,002	+4.4%
Oregon (Umatilla, Morrow, Gilliam, Sherman, Wasco, Jefferson, Crook, Deschutes, Klamath, Baker, Malheur, Union)	220,317	230,463	+4.6%
Nevada (Pershing, Nye, Mineral, Lander, Humboldt, Esmeralda, Churchill)	30,247	35,503	+17.4%
Northern California (Siskiyou, Shasta, Modoc, Tehana, Glenn, Colusa)	155,286	177,802	+14.5%
San Francisco area (Yolo, Solano, Sacramento, Contra Costa)	703,102	893,227	+27.0%
Southern California (Mono, Inyo, Kern, San Bernardino)	809,472	1,034,278	+27.8%
Total	2,325,703	2,799,651	+20.4%

Table 2.OV.10-4
Area Population Trends by Economic Area

Economic Area	Code	Population (1970)	% Change 1970-80	1970-90	1970-2000
Spokane, Wash.	154	687,982	3	3	3
Yakima, Wash.	156	407,607	1	1	3
Portland, Oregon	157	1,644,772	13	26	35
Eugene, Oregon	158	544,011	8	12	11
Redding, Calif.	169	179,165	3	10	14
Sacramento, Calif.	168	1,093,181	10	21	29
San Francisco, Calif.	171	5,102,971	14	30	43
Boise City, Idaho	159	266,946	2	10	15
Reno, Nev.	160	208,468	26	57	84
Las Vegas, Nev.	161	320,283	23	49	70
Los Angeles, Calif.	165	10,452,658	12	25	34
Great Falls, Mont.	094	223,407	-7	-6	-6
Minot, N.D.	093	182,383	-10	-18	-24
Bismarck, N.D.	096	144,938	-7	-7	-12
Aberdeen, S.D.	098	133,151	-11	-15	-19
Sioux Falls, S.D.	099	365,422	1	1	0
Waterloo, Iowa	105	427,118	0	-2	-5
Cedar Rapids, Iowa	080	330,715	7	15	21
Davenport-Rock Island-Moline, Ia.-Ill.	079	606,414	4	6	7
Chicago, Ill.	077	8,211,480	10	20	29
Ft. Wayne, Ind.	075	599,095	11	30	44
Lima, Ohio	069	277,084	6	15	22
Cleveland, Ohio	068	4,269,961	7	12	17
Pittsburgh, Pa.	066	3,738,298	1	2	2

Table 2.OV.10-4
Area Population Trends by Economic Area

Economic Area	Code	Population (1970)	% Change 1970-80	% Change 1970-90	% Change 1970-2000
Spokane, Wash.	154	687,982	3	3	3
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Chicago, Ill.	077	8,211,480	10	20	29
Ft. Wayne, Ind.	075	599,095	11	30	44
Lima, Ohio	069	277,084	6	15	22
Cleveland, Ohio	068	4,269,961	7	12	17
Pittsburgh, Pa.	066	3,738,298	1	2	2

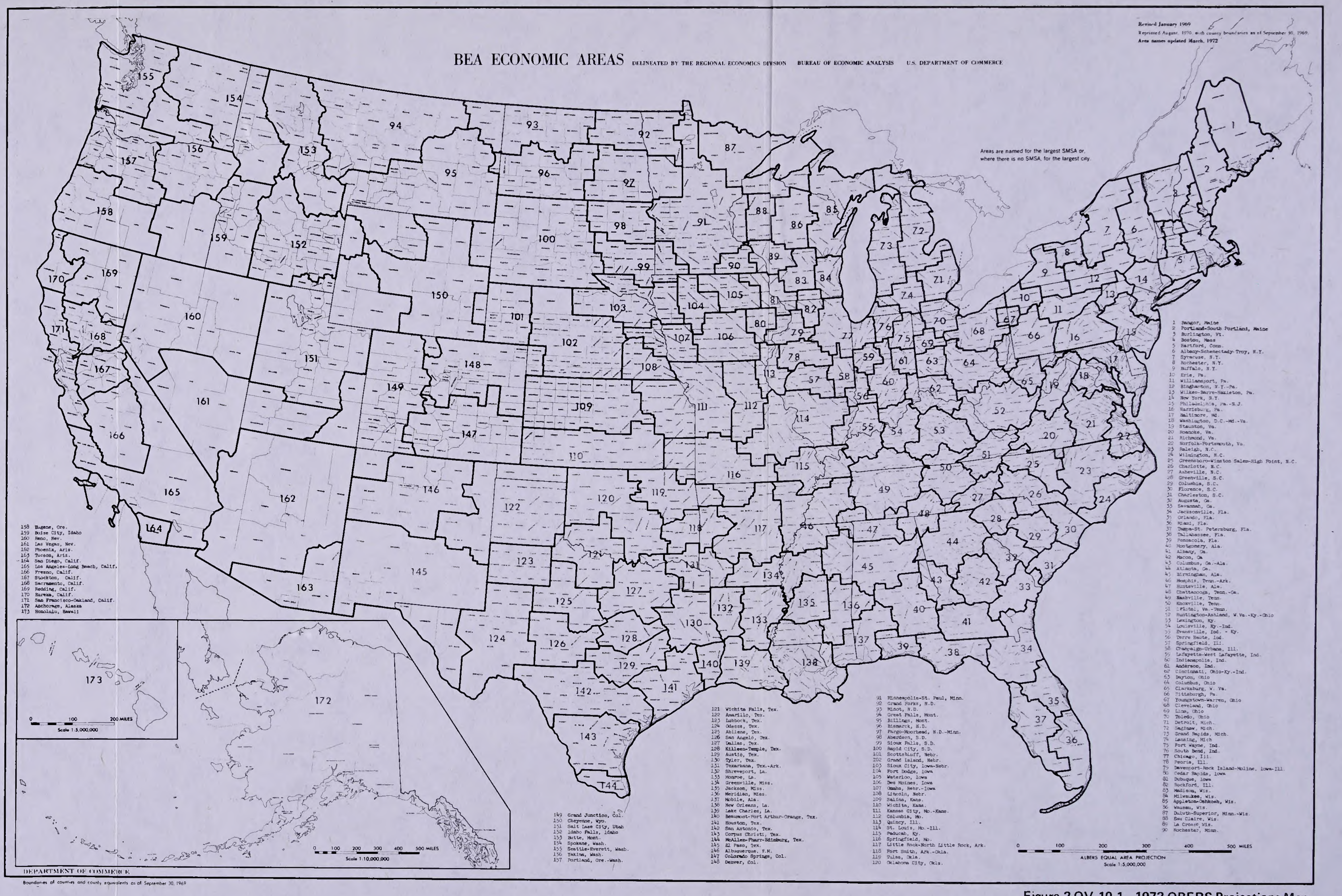
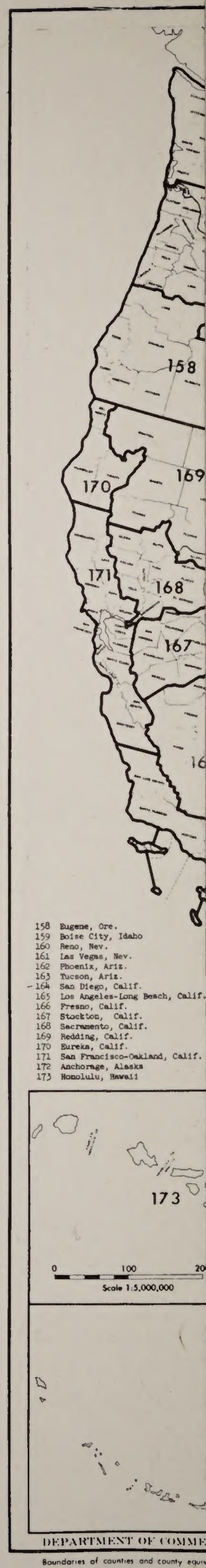


Figure 2.OV.10-1. 1972 OBERS Projections Map.


158
170
169
171
168
167
16
158 Eugene, Ore.
159 Boise City, Idaho
160 Reno, Nev.
161 Las Vegas, Nev.
162 Phoenix, Ariz.
163 Tucson, Ariz.
164 San Diego, Calif.
165 Los Angeles-Long Beach, Calif.
166 Fresno, Calif.
167 Stockton, Calif.
168 Sacramento, Calif.
169 Redding, Calif.
170 Eureka, Calif.
171 San Francisco-Oakland, Calif.
172 Anchorage, Alaska
173 Honolulu, Hawaii
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DEPARTMENT OF COMME
Boundaries of counties and county equiv

Nevada, and the Ft. Wayne, Indiana area between 1970 and 2000. The North will grow because it is a relatively undeveloped frontier while Nevada reflects the growth of the leisure industry and the Ft. Wayne area is one currently undergoing urbanization. The Western Grazing and Wheat Area will lose population as farming and grazing continue to become less labor intensive.

C. Government

All the States traversed have Governors and bi-cameral (2 houses) legislatures.

Alaska has boroughs (11 organized plus the unorganized borough) and cities (9 first class and 80 second class) as forms of local government. The boroughs are comparable to the counties generally found in the lower 48 States.

Canada contains both territories and provinces. The Northwest Territories have six categories of local government: cities, towns, villages, hamlets, settlements, and unorganized areas. In the Province of Alberta local government categories include cities, towns, villages, counties, municipal districts, improvement districts, and special areas.

D. Education

In Alaska, the average Native over 25 years old has not completed his primary education, while the average non-Native has completed his secondary education.

In the North Slope Borough, education is provided by the borough, the State, and the U.S. Bureau of Indian Affairs. Primary education for non-Natives is provided by the borough in Point Hope, Point Lay, and Anaktuvuk Pass. Secondary education is provided outside the borough (primarily in Anchorage by the State). Native education is provided by the Bureau of Indian Affairs in Barrow and Kaktovik (primary) and in Oregon and Oklahoma (secondary).

In the Northwest Territories, 84 percent of the Natives do not go beyond 8th grade as compared to 30 percent of the non-Natives in the Northwest Territories. The provinces provide primary and secondary education.

Along the Northern Border Pipeline, the average educational attainment of 12.1 school years is the same as the national average. Pipeline counties in California and Oregon range from a median of 12.1 years to 12.5 years in educational attainment. Pipeline counties in Nevada generally range from 12.0 years to 12.3 years except that Esmeralda County has a median of 11.0 years. Washington

pipeline counties are generally between 12.4 years to 12.8 years except for Columbia County, where the average level is 11.7 years. Idaho counties are the one group in the West Coast region averaging less than the national average; Boundary County, Idaho has a median attainment level of 11.5 years.

E. Health

In Alaska, Native health services are normally provided by the U.S. Public Health Service-Indian Health Service. Private health services cannot provide adequate service because there is a low ratio of doctors to people (97 doctors per 100,000 population) and because the immense size of the State limits access to health services. The U.S. Department of Health, Education, and Welfare has a "Health Services Development Project" in Alaska and the State also provides health services.

In Alaska's North Slope Borough, there are health service units in Barrow, Tanana, and Kotzebue. The U.S. Public Health Service maintains a health aide in Kaktovik providing elementary medical aid.

In the Northwest Territories, the government normally provides health services; in Alberta, a government health plan provides basic services.

The U.S. national average for health service availability is 160 doctors per 100,000 population. The Northern Border counties as a whole have health service availability similar to the national average; however, this is distorted by the concentration of doctors in populous urban areas. Rural areas in Montana, North Dakota, and South Dakota have low ratios of doctors to population. Similarly, rural areas in Idaho and Nevada also have low ratios of doctors to population. In terms of State data, California is well above the national average in health care availability, while Illinois, Minnesota, Ohio, Oregon, Pennsylvania, and Washington are near the national average.

F. Housing

Average housing in the 50 States is 69.1 percent single family and 53.4 percent built before 1950. Housing unit conditions vary greatly along the proposed route.

Alaskans, especially Natives, are among the most poorly housed U.S. citizens; Alaskan housing is more crowded and

more substandard than the U.S. average. This results in part from the low personal income of many inhabitants and the high cost of construction.

In the Northwest Territories, housing is crowded and over half is in fair to poor condition. Most housing is government owned and subsidized.

Along the Northern Border route and in the Idaho, Washington, and Oregon pipeline counties, housing is older than the national average and more likely to be single family owner occupied. In the Nevada pipeline counties, housing is close to the national average in age but is more likely than average to be single family, owner occupied.

California pipeline counties were also above the national average in single family owner occupied housing, but housing was much newer than national averages, with several counties (Sacramento, Contra Costa, Yolo, Shasta, San Bernardino, and Mono) having little more than half the national average percentage of homes built before 1950.

2.OV.11 Land Use

This section contains information on historic land uses, current land use, transportation facilities, transmission facilities, current land use planning efforts, and land use trends. In order to provide sufficient information on land uses and features found along the proposed pipeline route, the text has been arranged in geographic segments.

Most of the land to be crossed in Alaska, the Yukon Territories and the Northwest Territories is presently undeveloped; Natives use some of the land for subsistence hunting and fishing. In the Canadian provinces, the proposed route would cross large areas under intensive cultivation (primarily spring wheat) and areas which are grazed. Land uses for portions of the proposed route in the lower 48 States are shown in Table 2.OV.11-1.

A. Historic Land Uses

B. Current Land Use

Alaska

Until the discovery of the Prudhoe Bay oil field in 1968, basic land use in the Arctic Coastal Plain area of Alaska consisted of support for the subsistence-level

Table 2.OV.11-1
Land Uses Along Proposed Route Through the Lower 48 States 1/
(By Percentage)

Route	Croplands %	Range/ Watershed Conservation %	Woodland %	Commercial Quality Timber %	Rights-of-Way %	Water-Ways %	Urban %	Other %	Total %
Northern Border	76.0	16.0	4.1	NC	1.7	1.5 4/	.3	NC	100.0
San Francisco	46.1 3/	30.1 4/	NC	22.7	NC	NC	NC	1.0	100.0
Los Angeles	20.7	68.8 3/	NC	9.7	.4	.4	NC	NC	100.0

1/ Computed by Miles for Northern Border and San Francisco Routes, by Acreage for Los Angeles Route.

2/ Includes Roads, Railroads, Utility Corridors, etc.

3/ Includes Irrigated Pasture.

4/ Includes Flood Plains.

NC Not Classified under this Heading for this Route.

existence of the small population of native Eskimos, who fished, hunted, trapped and collected edible plants. The establishment of a U.S. military radar base in the 1940's and a station of the Distant Early Warning System (the DEW-line) in 1953 on Barter Island did not materially alter this basic land use.

All the land along the first 61 miles of the proposed pipeline route from Prudhoe Bay to the western boundary of the Arctic National Wildlife Range is owned by the State of Alaska. While subsistence fishing, hunting, and trapping continue in the Arctic Coastal area, the dominant land use in the State-owned land along the proposed route is becoming exploration, development, and transportation of oil and gas; 51 of the first 61 miles along the route are included under oil and gas leases. Although actual oil production and transport through the Trans-Alaska Pipeline System will not begin until at least 1977, oil and gas related facilities have been constructed in the area. Sand and gravel, which are being extracted from the bed and outwash plains of the Sagavanirktok River south of Prudhoe Bay, are the only hardrock minerals now being mined in the vicinity of the proposed gas pipeline.

Exploratory drilling activities have not been permitted within the Arctic National Wildlife Range. Some recreational use now occurs there. During the 1974 summer season some 100-150 people visited the Range; a smaller number actually crossed the proposed pipeline route. Recreational activities included sport hunting and fishing, boating, hiking, skiing, and sightseeing. Sightseeing visits to oil development sites in the Prudhoe Bay area are also reported.

Three small settlements are found in the vicinity of the proposed route through Alaska. Prudhoe Bay and Deadhorse are company towns near the route's starting point. The Native village of Kaktovik is located on Barter Island in the Beaufort Sea, more than 20 miles north of the route.

Two new ports and three of the four future compressor stations proposed for the Alaska pipeline segment would be located within the Arctic National Wildlife Range.

<u>Canada</u>

Most of the land in Canada near the proposed pipeline route is not under intensive development. In the Yukon and Northwest Territories, most of the land is of wilderness

character. Human activities in the past have consisted mainly of fur trading, subsistence-level hunting and fishing by semi-nomadic Natives, and oil production.

Most of the settlements near the proposed route in northern Canada are small and situated on the Mackenzie River. As people in the North have gradually concentrated themselves in urban areas, giving up at least in part their nomadic ways, towns such as Inuvik, Fort Simpson, and Hay River, all near the proposed pipeline, have grown.

Present day land uses in the Territories include fur trapping, subsistence hunting and fishing, commercial fishing, mining, and oil and gas exploration and production; however, each of these is important only in certain scattered locations. Logging is also found in a few locations. The Mackenzie River Valley is a natural transportation route to the North, and economic and industrial growth is occurring gradually along its length.

Some stockpile sites, with or without wharves, and some compressor stations would be located near small established communities in the Northwest Territories.

The proposed route would cross one potential ecological preserve in the northern Yukon Territory identified under the International Biological Program, and pass very near

potential preserves in the Mackenzie Delta and Fort Norman areas.

The proposed route crosses the 60th parallel and enters the southwestern Canadian provinces. By the beginning of the 20th century, Alberta, Saskatchewan, and Manitoba were under agricultural development. More recently, oil and gas exploration and development have appeared in Alberta and Saskatchewan, along with mining and tourist activities. Much of the land crossed by the proposed pipeline route as it passes through north central Alberta is rolling and forested; there are also large areas, formerly rolling grasslands, which are now under agricultural use. South of the Peace River in central Alberta, great expanses of agricultural land are found, large rectangular plots of spring wheat interspersed with grasslands and scattered stands of aspen; near Valleyview in this region, 75-85 percent of the land is used for grazing or agriculture. Farther south, near Calgary, large expanses of agricultural land, primarily in spring wheat, are encountered on the plain.

Along the Monchy Delivery Line through southeastern Alberta and southwestern Saskatchewan, large acreages of spring wheat are found in this gently rolling country,

frequently alternating with grazing in rougher terrain. Along the delivery line, farmlands occupy 35-50 percent of the total area, and in some areas, land use for farming approaches 100 percent. Along the Kingsgate Delivery Line through southwestern Alberta and southeastern British Columbia, agricultural land use is limited by the highly rugged terrain.

The part of Saskatchewan crossed by the Monchy Delivery Line is sparsely populated. Along the Kingsgate Delivery Line, small mining towns are found. The most populated area near the proposed route through Canada is in an arc between Edmonton, Calgary and Lethbridge, all in Alberta.

The proposed route would run through a number of oil and gas fields in British Columbia, Alberta, and Saskatchewan. Oil and gas production is now the largest industry in Alberta, and is highly important in Saskatchewan too. In southeastern Alberta and southwestern British Columbia, the route would cross areas where coal production is high. Some metal and nonmetal mining also occurs in these provinces.

Hunting and fishing are major recreational activities throughout British Columbia, Alberta, and Saskatchewan. A large number of Forest Service recreation areas are located in eastern Alberta; the proposed route would pass through or

near five of these. It would also cross or pass close to three provincial parks in Alberta and three provincial forests in British Columbia. (See also 2.OV.13 concerning Recreational Resources.) An Indian reserve adjacent to Calgary, Alberta, would also be crossed.

Northern Border

As shown in Table 2.OV.11-2, some 90 percent of the land traversed by the proposed Northern Border route is agricultural. As it enters the United States at a point near Morgan, Montana, the proposed pipeline enters the Great Plains Province. This area contains extensive gently rolling grasslands which came into agricultural use in the last years of the 19th century. The production of spring wheat by dry farming methods dominates the agriculture of this region; cattle are grazed where rougher topography and thinner soils are found. Feed grains (including corn), small grains (including barley, oats, and rye), hay and flax are also raised, along with sugar beets and potatoes.

Most of the land is not irrigated. However, the proposed route would cross two Bureau of Reclamation irrigation projects, the Buford-Trenton Project near the

Table 2.OV.11-2
Land Uses Along Northern Border Route

Land Use	Miles
Urban (Residential, Industrial, and Commercial)	4
Agriculture (Cultivated and Range)	1,470
Woodland	73
Rights-of-Way (Roads, Railroads, and Utilities)	27
Waterways and Flood Plains	24
Total	1,598*

* Not corrected for elevation.

Montana-North Dakota boundary, and the Heart Butte unit of the Missouri River Basin Project in south central North Dakota. The route would also cross the Federally-owned Oahe Reservoir in North Dakota.

There is a recreation industry based on hunting in Montana and on flat water fishing of the Fort Peck, Saskatchewan, and Oahe Reservoirs in the Dakotas, all near the proposed route. The land crossed by the route in this area would also include 270 miles of prairie pothole country, important as habitat for waterfowl and migrant shorebirds. Both the U.S. Fish and Wildlife Service and State governments have acquired scattered wetland areas in the Great Plains area in fee simple or as easements in order to protect habitat for migrant shorebirds and waterfowl.

The proposed route would cross the Fort Peck Indian Reservation in Montana for 88 miles and would cross a corner of the Standing Rock Indian Reservation in North Dakota. The Bureau of Land Management, besides managing scattered lands for a total of 19 miles along the proposed route in Montana and North Dakota, is responsible for management of Federal subsurface mineral rights under segments of prairie land for a total of 115 miles along the proposed route. The Little Missouri Grasslands, managed by the Forest Service,

also occurs in scattered tracts in North Dakota. It is possible that Federally managed areas in the North Dakota Badlands could receive increased recreation use in the future.

Coal, oil, and natural gas are extracted in Montana and North Dakota; some sand and gravel extraction also occurs near this part of the Northern Border route.

The proposed route next passes through the Central Lowlands Province, which is one of the outstanding grain-producing regions of the world. This area was settled and converted to agricultural use during the 19th century. Virtually all the land crossed is agricultural, and all but 15 percent of it is cropland; from Indiana through central Ohio, some 90 percent of the land is agricultural. The land is gently rolling or flat--generally flatter east of the Mississippi River. Scattered woodlots are also seen. Corn, soybeans, oats, and other feed grains are the most widely grown crops. Hay and winter wheat are also raised; so are beef cattle and hogs. Some land is in pasture. Near large cities, some dairy production is found, and truck and canning crops are also grown in the area near the Great Lakes. Moving from west to east, average farm size declines. Urbanization is gradually removing some land from

agricultural use in the eastern part of the Central Lowlands Province, especially along the part of the proposed route between Davenport, Iowa, and Chicago.

Recreation areas developed around lakes and rivers, along with State parks, are important regional recreation resources in the Central Lowlands area, and the proposed route would cross several of these. (See also 2.OV.13 concerning Recreational Resources.) Although the proportion of Federal lands along this portion of the Northern Border route is even smaller than in the Great Plains, the proposed pipeline would cross Federally-owned land at the Mississippi River crossing south of Clinton, Iowa. It would also cross the Salamonie Reservoir in Indiana and the Delaware Reservoir in Ohio; both are U.S. Army Corps of Engineers projects with recreation facilities now operated by the States.

Although oil and gas have been extracted in Illinois, Indiana and Ohio, production is now declining. Coal is still mined in Illinois near the proposed route. Sand and gravel, limestone, dolomite, clay and shale are mined along the route through the Central Lowlands.

Entering the Appalachian Plateau Province, the proposed route passes from sharply rolling terrain with scattered

groves of trees, into a more rugged forested area of ridges and valleys. Nearly half the area is in forest; sale of timber is an important source of income on some farms. Most of the remaining land is farmland, particularly in the valleys, although much farmland along the Ohio River has recently been diverted to industrial uses. Hay and some grain for dairy cattle and other livestock are the major crops; some of the farmland is in pasture. A variety of fruits and vegetables are also grown. The last few miles of the route, which terminates at Delmont, Pennsylvania 20 miles southeast of Pittsburgh, pass through several residential and recreational areas, including two wooded parks of regional importance.

Coal production is important in the Alleghany Plateau Province. Coal, oil, and natural gas are also extracted in this area, as are sand and gravel, clay, shale, crushed rock, and building stone.

Twenty-five urban areas of 50,000 people or more are found within a 100-mile corridor along the proposed Northern Border route, most of them east of the Mississippi River. (See Table 2.OV.11-3.) The route would pass just one mile north of Waterloo, Iowa. Many smaller industrial towns also

Table 2.OV.11-3
Urban Areas of 50,000 Population or More Within 100-Mile Corridor Along Northern Border Route

Sioux Falls, South Dakota	72,488
Waterloo, Iowa	75,533
Cedar Rapids, Iowa	110,642
Davenport-Rock Island-Moline, Iowa, Illinois	194,872
Peoria, Illinois	126,963
Bloomington-Normal, Illinois	66,388
Chicago, Illinois	3,336,957
Gary-Hammond-East Chicago, Indiana	330,187
South Bend, Indiana	125,580
Lafayette-West Lafayette, Indiana	64,112
Indianapolis, Indiana	744,624
Anderson, Indiana	70,787
Muncie, Indiana	69,080
Fort Wayne, Indiana	177,671
Lima, Ohio	53,734
Dayton, Ohio	243,601
Springfield, Ohio	81,926
Columbus, Ohio	539,677
Mansfield, Ohio	55,047
Canton, Ohio	110,053
Steubenville-Weirton, Ohio, West Virginia	57,902
Wheeling, West Virginia	48,188
Pittsburgh, Pennsylvania	520,117
Johnstown, Pennsylvania	42,476
Altoona, Pennsylvania	62,900

Source: United States Census 1970.

lie near the route as it moves into the eastern United States.

Four proposed compressor stations would be located 1,000 feet to 1 mile from farmsteads; proposed compressor stations and future compressor stations would be located 1/2 mile to 1 3/4 miles from 9 small communities; one proposed future compressor station would be located 1 1/2 miles north of the Waterloo, Iowa corporate boundary (1/2 mile from a small residential suburb of Waterloo); and one proposed future compressor station would be 3/4 mile from the Quad Cities Nuclear Power Company installation in Rock Island County, Illinois. Proposed compressor stations would be within 1,000 feet of a waterfowl production area in Clark County, South Dakota and within 1/2 mile of another in McIntosh County, North Dakota; compressor stations would also be located within 1 mile of Hendricks State Wildlife Management Area, South Dakota, within 1/4 mile of Bennett State Wildlife Management Area, South Dakota, and 1/4 mile from the boundary of a wooded recreation area at the Salamonie River and Reservoir in Indiana.

West Coast (San Francisco Leg)

Land uses along the entire route proposed for the San Francisco leg are approximately 46 percent agricultural (croplands and pasture), 30 percent conservation (rangeland grazing and watershed), and 23 percent forestry. Lands in the area of the proposed pipeline were converted to agriculture in the mid-19th century to meet the needs of the mining towns; use of irrigation began in earnest in the 1880's.

The proposed San Francisco route coincides with the route of the proposed Los Angeles leg for the first 206 miles from the Canadian Border to a point just south of the Snake River crossing in Columbia County, Washington. The proposed route enters the United States near Eastport, Idaho and first passes through the Kaniksu National Forest. The major land use along the first part of the route through Idaho, along the Moyie River, is forestry. However, mixed forests and croplands are found as the pipeline moves down in a southwesterly direction from the Rocky Mountains into rolling hills. Some livestock grazing and dairy production also occur in this part of Idaho. The pipeline would cross a flat prairie in its approach to the Spokane area; mixed

agricultural and residential uses are seen in the 15 miles preceding Spokane.

In Idaho, land ownership along the proposed route is generally private, except for the first 20 miles through the Kaniksu National Forest. The proposed route would pass very close to a number of established camping and recreation sites in northern Idaho. Hunting and fishing are very popular throughout the area. The route would pass within 1 mile of the residential outskirts of Sandpoint and Bonner's Ferry, both in Idaho. Reflecting a statewide trend, residential developments are growing rapidly around Idaho's Pend Oreille and Cocolalla Lakes; the proposed route would pass within one-eighth to one-half mile of such developments. Spokane is the largest city passed by the proposed route.

The proposed route continues in a southwesterly path through the rolling hills of Washington. Dryland farming is the principal land use in this area; crops include wheat, barley, and green peas. As the route approaches the Oregon border, livestock grazing is also evident. In north central Oregon both farming and grazing are found, but grazing accounts for more of the land use as the route heads south, a trend which has intensified in recent years due to

decreased annual rainfall. There is very little residential or industrial use along this part of the pipeline. In Washington and north central Oregon, most of the land to be traversed is private. The U.S. Bureau of Land Management manages scattered small parcels, notably several river canyons. The route also crosses 20 miles of the Crooked River National Grasslands, administered as part of the Ochoco National Forest. Fishing and hunting are popular in this region, and heavy recreation use is found above and below the pipeline's proposed crossing of the Snake River in Washington.

The proposed route passes within 3 miles of Bend and Redmond, both in central Oregon; it passes near several recreation areas associated with the lava beds near Bend. The route then passes south through the Deschutes and Winema National Forests in south central Oregon and the Modoc, Shasta and Lassen National Forests in north central California. The predominant land use along this part of the proposed route is forestry. In the lava country of the Modoc National Forest, livestock grazing and conservation use are found. Between 5 and 10 percent of the land along the route is irrigated and used to grow potatoes, grain, seed crops, and hay for pasture.

Over 50 percent of the land to be crossed along this part of the route is administered by the Federal Government, including the five national forests and some lands managed by the Bureau of Land Management. The rest of the land in this area is in privately owned farms and ranches. The route would pass near a number of established camping and recreation sites in south central Oregon. Intensive recreation use is increasing in the forested areas of northern California; development of recreational or second homes is also increasing in these areas. Heavy recreation use is found above and below the pipeline's proposed crossing of the Pit River near Lake Britton in northern California. Hunting and fishing are also very popular along this part of the proposed route.

The proposed route descends into the Central California Valley where the most important land use is agriculture; a variety of truck farm crops, fruits, nuts, and small grains are raised. A substantial amount of livestock grazing is also found, as well as dairy and poultry production near large cities. The agricultural area generally lies to the east of the proposed route; most of the grazing and conservation use is found on the mountain slopes to the west

of the proposed line. Most of the land to be crossed is privately owned.

The proposed route generally parallels a string of communities down the Central California Valley, and would run within 1 to 4 miles of several of them. It would pass near a rural/urban section of Burney, California. It would cross industrial/commercial land use areas of Red Bluff, California, and it would cross an area that is changing from agricultural to industrial/commercial near Willow, California. In Winters, California, the proposed route is adjacent to a residential subdivision, although further subdivision development has slowed. The termination point in Antioch, California is in an industrial/commercial area. Table 2.OV.11-4 lists 13 communities within 5 miles of the proposed route with populations of 2,500 or more.

Along the entire San Francisco leg of the proposed pipeline, there are nearly 600 dwelling units and about 40 industrial establishments (including existing pipeline compressor stations) within one-eighth mile of the right-of-way centerline. Several communities are located near enough to compressor stations that the inhabitants may react to the noise levels of construction or operation: Eastport, Idaho; Diamond Lake Junction, Oregon; residences south of Bonanza,

Table 2.OV.11-4
Communities of 2,500 Population
or More Within Five Miles of the
Proposed San Francisco Route

State / Community	Approximate 1970 Population
Idaho	
Bonner's Ferry	2,800
Sandpoint	4,000
Washington	
Spokane	170,000
Opportunity	16,600
Oregon	
Hermiston	5,000
Redmond	3,700
Bend	13,700
California	
Red Bluff	7,700
Corning	3,600
Orland	2,900
Willows	4,100
Vacaville	21,700
Antioch	32,100*

* 1973 Figure

California; Tionesta, California; Burney, California; and Rawson, California.

West Coast (Los Angeles Leg)

The proposed route of the Los Angeles leg coincides with the proposed San Francisco route for 206 miles from the Canadian border to a point just south of the Snake River crossing in Columbia County, Washington. Land uses along the route through Idaho and Washington have therefore been discussed above in conjunction with the San Francisco route.

The proposed Los Angeles leg turns south and enters Oregon, passing through rolling croplands to the foothills and western slopes of the Blue Mountains in northeastern Oregon. Some livestock grazing and timber harvesting also occur in this area.

The proposed route crosses small portions of the Umatilla National Forest and the Wallowa-Whitman National Forest and travels 12 miles through the Umatilla Indian Reservation; most of the remaining land crossed in this area is privately owned. Hunting and fishing are popular in northeastern Oregon, and family recreation uses such as camping and hiking are increasing there.

From southeastern Oregon to the Mojave Desert, arid conditions and sparse vegetation make livestock grazing the principal land use; wildlife habitat and recreational uses are associated with the grazing. Limited irrigated farming also occurs in valleys within these desert areas, and some mining is found in Nevada and California.

As the proposed route approaches the Los Angeles area, more farming is found in Kern County; in San Bernardino County, more dairy and poultry production reflects proximity to the Los Angeles market. In San Bernardino County, many new homes are being built for residential and recreational use as the Los Angeles metropolitan area expands. Mobile home parks are also growing.

Almost all the rangelands along the route in southeastern Oregon and Nevada are Federally-owned and managed by the U.S. Bureau of Land Management. Along part of the Nevada portion of the route, land grants by the Government to the railroads have resulted in a checkerboard pattern of private and Federal ownership.

The proposed pipeline would cross part of the Inyo National Forest at the beginning of the California portion of the route, and the San Bernardino National Forest near its termination point. Most of the land crossed in Mono and

Kern Counties is Federally-owned. In Inyo County, half the land crossed is private, one-fourth is Federal, and one-fourth is owned by the City of Los Angeles to protect the City's water supply. In San Bernardino County, half the land crossed is privately-owned and half is Federal. The proposed route crosses corners of the Naval Test Station at China Lake and Edwards Air Force Base, which contain aircraft landing fields and large bomb and weapon testing sites.

Big game and upland bird hunting are popular in southeastern Oregon and in Nevada. All along the proposed route through California, tourism is heavy and all types of recreation use are found. In California, as in Nevada, offroad vehicle use is heavy. The proposed route would cross a private motorcycle park 10 miles south of Ridgecrest, California.

Twenty-one urban areas of 2,500 population or more are in the vicinity of the Los Angeles leg. (See Table 2.OV.11-5.) The largest of these are Spokane, Washington, and San Bernardino, California. The proposed route would pass through a developing subdivision of Winnemucca, Nevada. The applicants have identified 12 potential compressor sites for the Los Angeles leg, including one site which is two miles

Table 2.OV.11-5

Communities of 2,500 Population or More Near Proposed Los Angeles Route

State	1970 Population	Distance from Pipeline (Miles)
Community		
Idaho		
Bonner's Ferry	2,796	2
Sandpoint	4,144	1
Coeur d'Alene	16,228	7
Washington		
Opportunity	16,604	4
Spokane	170,516	4
Walla Walla	23,619	3
College Place	4,510	5
Oregon		
Milton-Freewater	4,105	4
Pendleton	13,197	25
La Grande	9,645	7
Baker	9,354	1
Ontario	6,523	40
Nevada		
Winnemucca	3,587	1
California		
Bishop	3,498	22
Ridgecrest	7,629	3
Barstow	17,442	30
Lenwood	3,834	13
Victorville	10,845	10
Apple Valley	6,702	<1
Hesperia	4,592	15
San Bernardino	104,251	

Source: Population Data from United States Census 1970.

from Lone Pine, California, and immediately north of Owens Lake.

C. Transportation Facilities

Alaska

Aircraft are heavily used for both local travel and travel to locations distant from the Arctic Coastal Plain. Major private airstrips are located at Prudhoe Bay and Deadhorse. Daily commercial service is available at Barrow, located on the seacoast to the west of the area immediately influenced by the proposed gas pipeline.

Approximately 100 miles of local private service roads are found in the Prudhoe Bay area; the rest of the North Slope Borough, which covers a large portion of northeastern Alaska, is virtually roadless. In the Arctic oil and gas fields, snow and ice roads and low-ground-pressure vehicles are widely used. In Fall 1974, the 400-mile-long North Slope Haul Road, an all-weather gravel road from the Yukon River to Prudhoe Bay, was completed by Alyeska. When a bridge across the Yukon is completed in 1976, this road will connect Prudhoe Bay with the existing State highway system in southern Alaska.

The Beaufort Sea is navigable about four months each year. At present there are no deepwater ports on the sea, but Prudhoe Bay has port facilities to accommodate barges bringing equipment to the oil and gas fields. River travel in the area is negligible.

Although there is presently no rail service to the Prudhoe Bay area, the Alaska Railroad has considered extending the existing railroad net northward to Prudhoe Bay from Fairbanks. The route would generally follow the Trans-Alaska Pipeline.

Canada

The area in Canada to be affected by the proposed pipeline route is served by major air carriers and by some bush pilots. In the Northwest Territories, usable airstrips presently exist at Inuvik, Norman Wells, Fort Simpson, and Hay River. There are also airstrips at Fort Norman, Wrigley, and Fort Good Hope, all in the Northwest Territories (N.W.T.), which would be improved for use.

Highway access to the proposed route through Canada is presently limited, although about 30 trucking companies do operate between Edmonton, Alberta; Fort Simpson, N.W.T.; and

Yellowknife, N.W.T. When completed, the Dempster Highway will connect Whitehorse in the Yukon Territory with Inuvik. A portion of the Dempster Highway in the Mackenzie Delta between Fort McPherson, N.W.T. and Arctic Red River, N.W.T. which would parallel the proposed pipeline route will soon be open (see Figure 2.OV.11-1), and construction between Arctic Red River and Inuvik is proceeding.

The Dempster Highway is already open between Whitehorse and Dawson, Yukon Territory; construction is proceeding between Dawson and Fort McPherson with the first 290 miles north of Dawson already completed. Any required highway access to the portion of the proposed pipeline between the Alaska-Canada border and the Mackenzie Delta would require extensive construction of access roads from the Dempster Highway.

Planning is proceeding on the proposed Mackenzie Highway, which would parallel the proposed route within a few miles, connecting Travaillant Lake Junction, N.W.T., Arctic Red River, and Inuvik with Fort Simpson, N.W.T., to the south; only short access roads would have to be constructed to the pipeline route. Access to the pipeline segment from Fort Simpson south to Peace River, Alberta, would be more difficult; extensive access roads would have

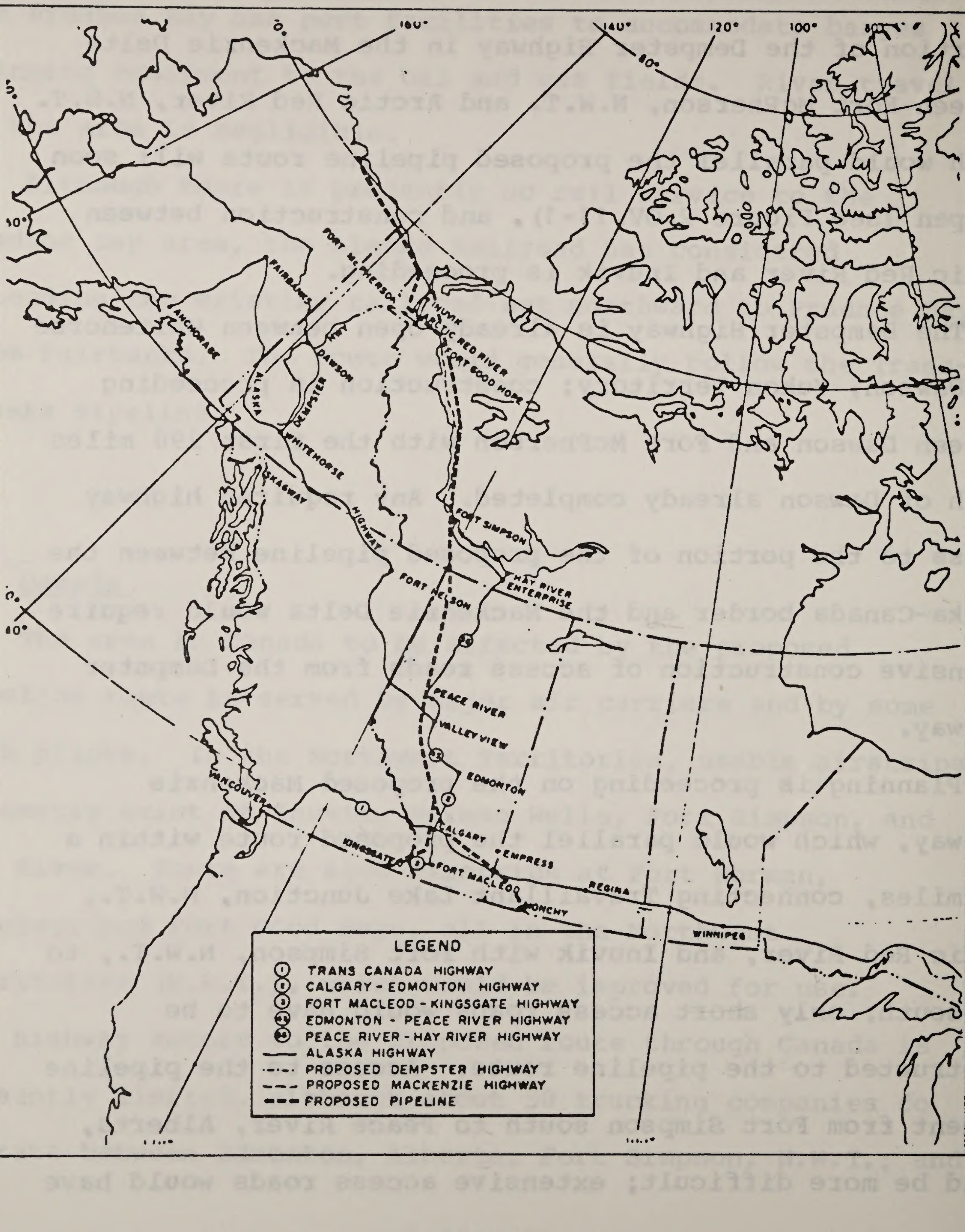

Figure 2.OV.11-1. Western Canada showing locations of existing major highways.

to be constructed from existing highways east of the route which connect Fort Simpson with Hay River, N.W.T., and Hay River with Peace River. For the pipeline segment between Peace River and Calgary, Alberta, access roads would be needed from the existing Peace River-Edmonton (Alberta) and Edmonton-Calgary highways. The Alaska Highway also crosses the proposed route south of Peace River. In southern Alberta, the Trans-Canada Highway runs east-west near the Monchy Delivery Line. The Kingsgate Delivery Line would be somewhat accessible from highways connecting Calgary with Fort McLeod, Alberta and Fort McLeod with Kingsgate, British Columbia.

Besides using trucks to transport materials, the Applicant would use river barges and railroad transportation. A railroad line presently extends north as far as Hay River, located on the Great Slave Lake in the southwestern part of the Northwest Territories. Waterway transportation is already widely used in Canada and barge service operates during the summer months between Hay River and the Beaufort Sea via a series of rivers and lakes. Barges would be used to transport several million tons of pipeline materials, especially to pipeline construction sites north of Fort Simpson, N.W.T.

Northern Border

Commercial air service to major cities and towns along the proposed Northern Border pipeline is adequate. Commuter-type service to the larger rural communities from major cities and between rural communities is regionally available. There are also many local airfields along the route for use by charter or private planes.

The proposed pipeline would cross 99 State highways, 39 U.S. highways, 15 interstate highways, and numerous county roads. The availability of highways and roads, and thus available access to the proposed route, generally increases from west to east. Because existing roads cross the proposed route so infrequently in the less populated areas of Montana and North Dakota, more than 50 percent of the Applicant's temporary roads would be built in these States.

The proposed route would cross 12 navigable rivers or streams. There are two crossings of the Missouri River in North Dakota; the rest of the crossings are at the Mississippi River and eastward. All the navigable streams carry recreational boat traffic. Commercial traffic is limited to the following rivers, with their average monthly tonnages shown: Mississippi, 2 million tons; Illinois, 2.5

million tons; Monongahela, 1.7 million tons; and Ohio, 2.5 million tons.

The proposed route crosses 99 railroad lines. Rail access is limited in Montana and in western North and South Dakota. In the mid-State grain producing areas, however, there are numerous railroad lines, many converging in Chicago. An even heavier concentration of tracks is found along the eastern part of the Northern Border route; many emanate from the major population centers of Cincinnati, Columbus, Toledo, Cleveland, and Pittsburgh.

West Coast (San Francisco Leg)

Aircraft facilities are generally available near the proposed San Francisco leg. An adequate number of highways or paved roads are found all along the proposed route; the smallest proportion of roads is found in the Southern Cascades area of northern California. The proposed pipeline would parallel U.S. 97 for about 170 miles through central Oregon. It would parallel U.S. 5 and 505 for approximately 115 miles through the Central California Valley. The Moyie River Road, a major artery at the head of the proposed route in northern Idaho, has severe bridge weight limits.

Navigable rivers in the area influenced by the proposed pipeline include the Snake River between Pasco, Washington, and Lewiston, Idaho; the Columbia River from Pasco, Washington to the Pacific Ocean; the Walla Walla River in Washington and the Sacramento and San Joaquin Rivers in California. In northern Idaho many lakes, such as Coeur d'Alene Lake and Pend Oreille Lake, and several rivers, such as the Pend Oreille, are used for logging.

The proposed gas pipeline would cross a large number of major railroads all along the route; the route runs parallel to a number of these lines for substantial distances.

West Coast (Los Angeles Leg)

Local aircraft landing facilities are generally available along the Los Angeles leg of the proposed route; only three proposed compressor sites are expected to require construction of landing strips.

In northeastern Oregon, a number of highways and paved roads are found in the vicinity of the proposed pipeline route. Highways and paved roads are also found near the proposed route through southeastern Oregon and Nevada, but there are proportionally fewer. Along the northern portion

of the route through California, the number of roads crossing the route is limited by the mountain ranges on both sides. However, the proposed pipeline follows U.S. 395, a heavily traveled north-south route connecting Nevada with southern California, most of the way from the California-Nevada Border to Cajon. More highways and roads are found near the proposed gas pipeline as it approaches the Los Angeles metropolitan area.

There are fewer railroads in the vicinity of the proposed pipeline in Oregon, Nevada, and California than there are in Idaho and Washington. The proposed pipeline makes seven railroad crossings in Oregon, two in Nevada, and five in California. In California, the proposed route parallels the Southern Pacific Railroad from Owens Lake to the south end of Indian Wells Valley, crossing the railroad three times. The route crosses two other major rail lines as it traverses the Mojave Desert to Cajon.

D. Transmission Facilities

Alaska

There is no electric power service grid in the Alaskan Arctic; presently, all electric power in Kaktovik and the

Prudhoe Bay area is produced by local power generators. Similarly, no regional water supply system is available; existing settlements take their water directly from nearby water bodies.

The oil and gas used in the Prudhoe Bay area are locally extracted; a small oil refinery at Prudhoe processes the crude oil for local use.

Radio and radio-telephone are the primary means of communication in the Alaskan Arctic; the communications system is generally oriented toward industry and defense. Private industry is now establishing an extensive radio network, including satellite facilities, to serve the Prudhoe Bay area.

Canada

Various electrical power sources are used in the Canadian provinces. In Alberta, for example, oil, gas, coal, and hydroelectric power are all used to produce electricity; communities in more mountainous areas in particular use hydroelectric power.

In the permafrost zone of northern Canada, public water supply systems rely on surface water sources; south of the

permafrost zone, both surface and groundwater may be used. In the Territories, many small communities use hand-carried or informal water delivery systems. In some of the larger growing communities, such as Inuvik, Hay River, Norman Wells, and Yellowknife (all in the Northwest Territories), water is treated and piped or commercially delivered, and sewage systems have been established. However, in these communities use of facilities has nearly reached or exceeded maximum capacity; in some communities, poor ground conditions also contribute to sewage system problems. Generally, irrigation is not used for agriculture in the area crossed by the proposed route.

Several major gas pipelines now exist in the area of the proposed route. (See Figure 2.OV.11-2.) One gas line of the Alberta Gas Trunk Line Company Limited originates in northeastern Alberta; it runs southwestward, crossing the proposed route several times near the center of the province before it heads eastward, paralleling the proposed Monchy Delivery Line as far as the Alberta-Saskatchewan border. Here it delivers gas to Trans-Canada Pipeline Limited, which distributes gas as far as eastern Canada and the Great Lakes region of the United States; the proposed Monchy Delivery Line would have a connection with the Trans-Canada line.

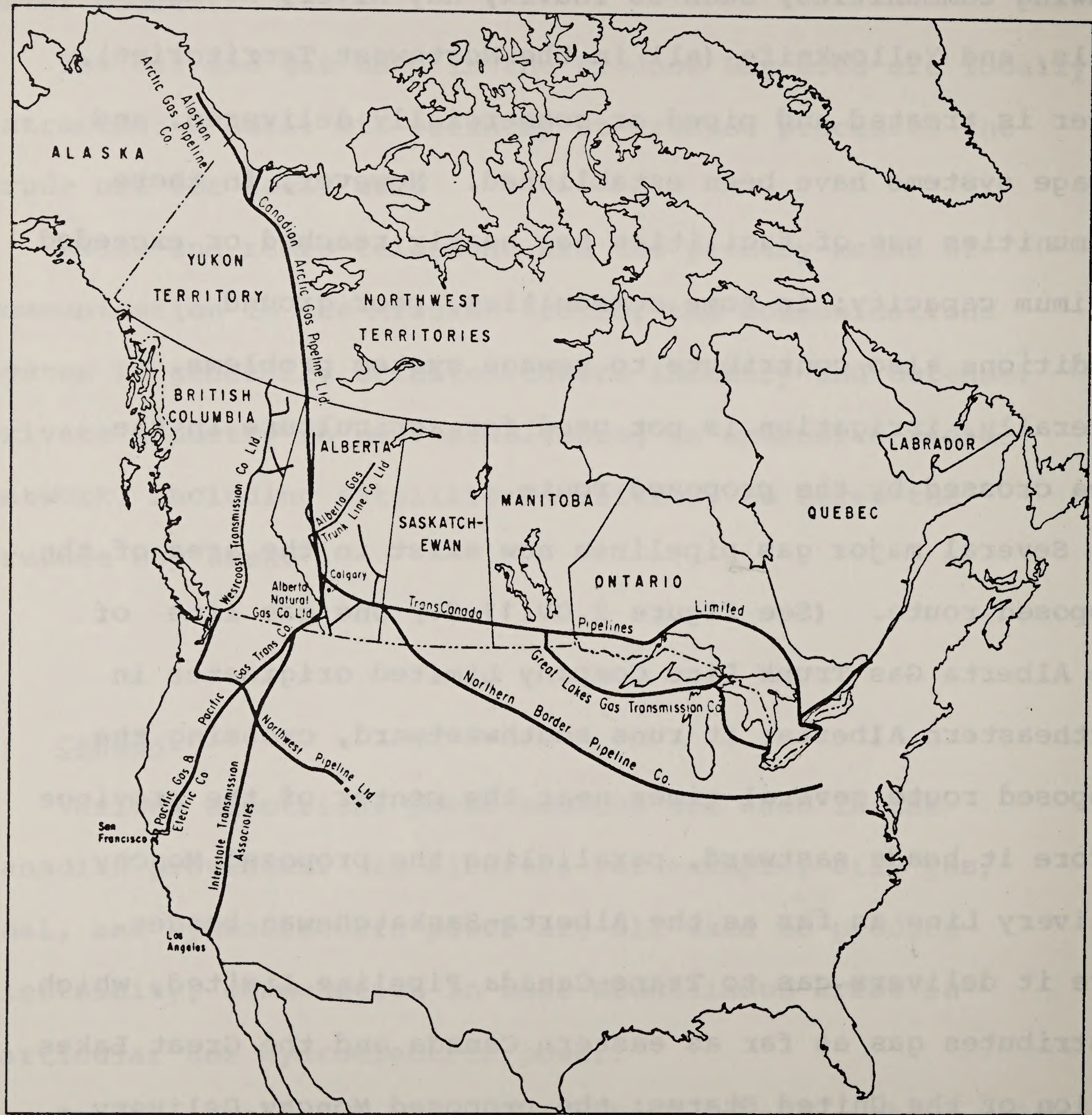

Figure 2.OV.11-2. Proposed Canadian and Alaskan Pipelines for Arctic gas and connections to southern Canadian and U.S. pipelines.

A second Alberta Gas Trunk Line Company Limited gas line would generally parallel the proposed pipeline from a point in northern Alberta to Caroline Junction, and would parallel the proposed Kingsgate Delivery Line part of the way to Kingsgate. Near Fernie, British Columbia, the Trunk Line gas line delivers gas to Alberta Natural Gas Company Limited, which would parallel the proposed Kingsgate Delivery Line the rest of the way to Kingsgate, and have a connection with it; the Alberta Natural Gas Company Limited line now makes deliveries to Interstate Transmission Associates at Kingsgate. The second Alberta Trunk Line Company Limited line ends at the Canada-United States border with a delivery to the Montana Power Company.

To the west of the proposed route, the West Coast Transmission Company Limited gas pipeline extends from near the northern British Columbia border to a delivery point at the British Columbia-Washington State border with Northwest Pipeline Limited.

Petroleum pipelines are also numerous in Alberta and Saskatchewan, especially in Alberta; many lines run close to and in places parallel the proposed gas pipeline. The potential for future development of a Mackenzie Valley oil pipeline is presently being studied.

Where public communication networks exist in Canada, they could be used in constructing the proposed pipeline. However, the Applicant also expects to install a microwave radio system with more than 80 communication sites, a company phone system, and a mobile radio system.

Northern Border

The proposed Northern Border route would cross 36 major power transmission lines; the density of powerlines generally increases along the route from west to east. The proposed route would share electric powerline rights-of-way in Iowa, Illinois, Ohio, West Virginia, and Pennsylvania; no shared right-of-way is longer than 5 1/2 miles and the total shared right-of-way is 13 miles.

There is little irrigated agricultural land along the proposed Northern Border route. A small section of the Buford-Trenton Irrigation Project is crossed in North Dakota, and a larger section of the Bureau of Reclamation's Oahe Irrigation Unit in South Dakota. In the middle portion of the Northern Border route which is within the Upper Mississippi River Basin, groundwater is the primary water supply source for most communities. Many communities along

the Northern Border route to the east and west of this area obtain public water supplies from surface water.

The proposed gas pipeline would cross 29 major natural gas pipelines along the Northern Border route. It crosses two primary distribution lines in Montana and western North Dakota. It makes deliveries to other lines near Aberdeen, North Dakota; Fairmont, Minnesota; Mason City, Iowa; Mendota, Illinois; Kankakee, Illinois; Rensselaer, Indiana; Berne, Indiana; Mt. Vernon, Ohio; Canonsburg, Pennsylvania; and Delmont, Pennsylvania. A large number of gas lines are crossed in central Ohio, northern West Virginia, and western Pennsylvania as major distribution lines bring natural gas across the county from gas fields in the Southwest.

The proposed Northern Border route would cross 35 major crude oil, liquefied natural gas, and petroleum products lines. A large concentration of these lines are crossed at the eastern end of the route because they originate from oil fields in eastern Ohio, West Virginia, and western Pennsylvania.

West Coast (San Francisco Leg)

There are numerous major and minor electric transmission lines all along the San Francisco leg of the proposed pipeline; the route would parallel existing powerlines for a total of 160 miles in south central Oregon, the Modoc National Forest (northern California), and the Central California Valley. Several electric transmission facilities are passed just east of Spokane. Most electric power in the Pacific Northwest is hydroelectric power produced by the Bonneville Power Administration. Northern Idaho residents are also facing a proposal for installation of a 500-kV (kilovolt) electric transmission line from Hot Springs, Montana to Spokane. In the San Francisco area, some of the electrical power now used is from geothermal steam.

The proposed pipeline would cross many irrigation canals and ditches all along the route. Most public water supplies in Idaho and Washington come from surface water, but since surface water is limited along much of the proposed route through Oregon and California, most public water supplies along the proposed route come from groundwater. In the Central California Valley, some communities along the route depend at least partly on local surface water; this includes Sacramento and many communities just north and east of the

San Francisco peninsula. The peninsula itself receives water from the Tuolumne River in the Sierra Nevadas via the Hetch Hetchy Aqueduct.

The proposed 42-inch outside diameter gas pipeline would parallel the existing 36-inch outside diameter gas pipeline of the Pacific Gas Transmission Company and the Pacific Gas and Electric Company from the Canadian border near Kingsgate, British Columbia to Antioch, California, with the exception of a 21.4-mile segment through the John Day River Canyon in north central Oregon. The proposed pipeline would cross two natural gas pipelines in Washington and El Paso Natural Gas Company's 22-inch gas pipeline in Oregon. It would also cross numerous small gas lines owned by the Pacific Gas Transmission Company and would make deliveries to them through 19 taps. In addition, deliveries are made to El Paso National Gas Company through 20 taps.

The proposed pipeline would cross three oil product pipelines in Washington. A microwave radio system now used between facilities along the existing Pacific Gas Transmission Company pipeline would serve the new pipeline as well.

West Coast (Los Angeles Leg)

In Oregon, most electricity is generated by regional hydroelectrical facilities. Electric power generating facilities serving the portions of Nevada and California affected by the Los Angeles leg of the proposed pipeline may be powered by natural gas, fuel oil, coal, or a combination of these. In addition, some nuclear-powered facilities are used in California, and hydroelectric power from the Colorado River is also used in the State.

In Oregon, must public water supplies in the area affected by the proposed pipeline come from groundwater. The gas pipeline would cross the Joe West Reservoir site in northeastern Oregon. As the route moves south through southeastern Oregon, west central Nevada and the valleys of central California, surface water becomes more scarce. In Nevada, the only perennial river crossed by the proposed route is the Humboldt (the Quinn River is also crossed, but at its headwaters); irrigated farming can be carried on only in the valleys. Most municipal water supplies depend on groundwater from local wells, although some municipalities in Nevada also use water piped from the California mountains, which may be available only intermittently.

In California, the only perennial river crossed by the proposed route is the Owens. Municipal water supplies may come from local wells or the Colorado River. The Los Angeles Aqueduct, which carries high quality mountain run-off or, in low-water season, groundwater pumped from Owens Valley wells, diverts a major portion of the valley's water supply for use in Los Angeles; some Owens Valley communities can also take water from the aqueduct for municipal use. The proposed gas pipeline would parallel the aqueduct through the Owens Valley to a point near the Inyo-Kern County line. Numerous irrigation ditches as well as waterlines traverse the southern part of the route through California.

In Oregon, the proposed gas pipeline would parallel an existing gas pipeline of the Northwest Power Company for 88 miles from Meacham to Rye Valley. The proposed gas pipeline then heads south crossing one major gas pipeline in Nevada. It crosses four more major gas lines in the Mojave Desert area before terminating in Cajon.

There is one oil products pipeline in the vicinity of the proposed gas pipeline in northeastern Oregon. Also, several major oil products pipelines run just south of the termination point in Cajon, California.

Microwave radio towers are used for commercial and private communication along much of the proposed gas pipeline route. In Nevada, the proposed route also crosses the extension of the Trans-Atlantic cable running from the eastern United States to the West Coast.

E. Land Use Planning

F. Expected and Potential Trends

<u>Alaska</u>

Authorities with responsibility for land use planning in the area of Alaska affected by the proposed gas pipeline include the Village of Kaktovik, the North Slope Borough, the State of Alaska, the Joint Federal-State Land Use Planning Commission, and the U.S. Fish and Wildlife Service acting for the Secretary of the Interior.

As a second-class city, the Village of Kaktovik may exercise authority for planning, platting, and zoning, but so far has taken little action. The North Slope Borough has mandatory responsibility for planning, platting, and zoning, but so far such plans are in the formative stages only.

Until recent years, land ownership in northeastern Alaska was almost exclusively Federal. However, substantial

acreages are now being selected by and transferred to the State of Alaska under provisions of the Alaska Statehood Act. The State of Alaska has already selected lands in the Prudhoe Bay area and classified a large portion of them as resource management lands; most of these resource management lands are leased for oil and gas exploration.

Under the Alaska Native Claims Settlement Act, Native corporations formed all over the State, including the Kaktovik Village Native Corporation and the North Slope Regional Native Corporation, will be able to acquire lands. The lands to be selected by the Kaktovik Village Native Corporation for corporation use could include up to 108 acres that are now part of the Arctic National Wildlife Range. The North Slope Regional Native Corporation selections are expected to include some State lands in northeastern Alaska.

The Alaska Native Claims Settlement Act also provided for establishment of the Joint Federal-State Land Use Planning Commission. In August 1973, the Commission submitted recommendations to the Secretary of the Interior on the use of 80 million acres of Federal lands identified for potential addition to the national park, forest, wildlife refuge, and wild and scenic rivers systems. The

Commission is also authorized to undertake a process of comprehensive land-use planning, but a statewide land use plan has not been issued.

The Secretary of the Interior has proposed that the Arctic National Wildlife Range be enlarged and included in the National Refuge System; the proposal includes a provision for the issuance of permits for mineral exploration and development. The Secretary has also recommended that suitability of the enlarged Arctic National Wildlife Range for inclusion in the Wilderness System be studied.

Besides the expansion of the Arctic National Wildlife Range, the future may also see the establishment of several new national parks within the North Slope Borough. Expanded exploration and development of oil and gas can also be expected. Whether Prudhoe Bay, whose residents now are mostly temporary, will emerge as a permanent population center is uncertain. In view of the proven and speculative oil and gas reserves in the area, a fluctuating work force could be in the area for 25 years or longer.

Canada

In Canada's Yukon Territory and Northwest Territories, government entities which could become involved in land use planning include the Federal and the territorial governments. The territorial governments have legislative powers similar to those of provincial legislatures, but all natural resources except game are still the responsibility of the Federal Government. In British Columbia, Alberta, and Saskatchewan, both the Federal and provincial governments could become involved. However, there is no indication in the Applicant's materials that comprehensive land use planning is taking place.

Both the Federal and territorial governments are examining sites for possible designation as national or territorial parks. The proposed Nahanni National Park would lie west of the proposed route in the vicinity of the Liard River in southwestern Northwest Territories; a national park at Toker Point on the Arctic Coast 50 miles northeast of the proposed route is also being considered. Proposals have also been made on occasion for a Yukon Wildlife Range; it would adjoin the Arctic National Wildlife Range at the Alaska-Canada border, and the proposed route would run through it.

According to the Applicant, no marked changes are foreseen in the level of activity in trapping, hunting, fishing, agriculture, forestry, commercial fishing, mining, or oil and gas development through 1985.

Northern Border

Government entities with responsibility for land use planning along the route of the proposed gas pipeline include the States, counties, and localities. The Fort Peck Tribal Council could become involved in land use planning; Federal agencies with management responsibilities along the Northern Border route could have some effect but the Federally-managed acreages here are small. The soil conservation districts, which are concerned with protection and conservation of natural resources on a county or watershed basis and prepare both long-range and annual plans, could have effects; so could special purpose districts such as irrigation, water, drainage, and weed control districts.

Table 2.OV.11-6 shows that the States along the proposed Northern Border route have completed a number of statewide comprehensive outdoor recreation, historic preservation,

Table 2.OV.11-6
State Comprehensive Plans Completed or in Preparation
Along Proposed Northern Border Pipeline

State	State Comprehensive Outdoor Recreation Plan	State Historic Preservation Plan	State Economic Development Plan	State Water Plan
Montana	Completed	Completed	Completed	Completed
North Dakota	Completed	Completed	Completed	
South Dakota	Completed	Completed	Completed	In Preparation
Minnesota	Completed	Completed		
Iowa	Completed	Completed	Completed	Completed
Illinois	Completed	Completed		Completed
Indiana	Completed	Completed		Completed
Ohio	Completed	Completed		Completed
West Virginia	(Route crosses 8 miles only)			
Pennsylvania	Completed	Completed	Completed	In Preparation

economic development, and water plans. Most of the States are also coming along in their programs to identify flood plain areas which should be protected and designated for uses such as open space, parks, and recreation. Generally, the counties along the route are now in the process of developing future land use plans and county zoning regulations, and approximately one-fourth of the counties have issued a land use or zoning plan. A few cities and towns near the proposed pipeline also have a land use or zoning plan. In the highly populated area along the route in southwestern Pennsylvania, city zoning regulations, especially subdivision regulations, may affect the pipeline.

In Montana, some economic development planning is being done on the Fort Peck Indian Reservation. In Ohio a State transportation plan has been completed. In Pennsylvania, a State land use plan is now being prepared; existing sedimentation and erosion regulations in Pennsylvania are also likely to affect the proposed pipeline.

The Little Missouri River in North Dakota and the Wapsipinicon River in Iowa (the latter now designated as a "Recreation River") are being studied for potential addition to the Wild and Scenic River System. The State of Indiana

is studying the possibility of designating the Wabash River as a scenic river.

In the future, the agricultural land use which now predominates in Montana, North Dakota, South Dakota, and Minnesota is expected to continue. More marginal land may be brought into spring wheat production. The scarcity of water west of the Missouri River is a factor limiting future industrial developments; however, if coal gasification becomes a reality in the future, eastern Montana and western North Dakota would be affected. Commercial coal gasification plants are presently under consideration in this area; their development would cause a population increase with conversion of some grazing lands to plant sites and expanded communities. Large land areas would be used as mining sites.

In Brown and Spink Counties in northeastern South Dakota, a proposed Bureau of Reclamation irrigation project could convert as much as 495,000 acres of nonirrigated range and cropland to irrigated cropland.

In the mid-State grain producing segment of the proposed route, agriculture is likely to remain the primary land use, but population growth is expected to place demands on agricultural lands near population centers.

In the eastern Ohio-West Virginia-southwest Pennsylvania segment, where most lands are used for agriculture or forestry, future land use is expected to follow the existing pattern with some increase in urban usage. Recreation demands by urban populations may accelerate the use of flood plains for recreation.

West Coast (San Francisco Leg)

Governmental entities with responsibilities for land use planning in the area surrounding the proposed San Francisco leg include the governments of the States and counties through which it passes. Planning by the U.S. Forest Service and the U.S. Bureau of Land Management also affects the area around the proposed route. In all the States affected--Idaho, Washington, Oregon, and California--comprehensive land use plans and zoning have been or are being developed. This planning and zoning does not specifically address the question of transmission or utility corridors, but it is expected that the proposed pipeline right-of-way and associated facilities can be accommodated.

The State of California Code requires each county to include in its comprehensive land use planning elements of

land use, circulation, housing, conservation, open space, seismic safety, fire and geologic hazards, transportation noise, and scenic highways. Most California counties have zoned Federal lands along the proposed route as open space; most other lands along the route have been zoned for open space, agriculture, or recreation.

Recreation land use is highly important along the proposed San Francisco leg. Segments of the John Day River in Oregon (which is now recognized as a "National and Scenic River"), the Moyie and Kootenai Rivers in Idaho, and the Sacramento River in California have all been identified as potential additions to the Wild and Scenic River System. The Snake River Gorge in Washington has been identified in the Washington State Recreational Trails Program as a hiking and horseback riding trail and water trail. The Bureau of Land Management is considering an area of the public lands 1 mile east of the proposed route in northern California for designation as a primitive area; adjacent to this area on the west is a 28,000-acre nondesignated roadless area of equal value administered as part of the Shasta National Forest.

In the future, continued expansion of recreational and recreational/residential development in northern Idaho is

expected. This is occurring on private lands with the subdivision of rural-type recreation property along streams and lakes. In the nonurban areas of Washington and north central Oregon, population growth is expected to be slow and little change in prevailing agricultural land use is anticipated. With increased irrigation, some areas now in grazing and conservation use could be converted to agricultural use.

In the portions of south central Oregon and California affected by the proposed route, continued residential expansion around existing population centers is anticipated. Bend, Oregon and Burney, California will probably experience continued subdivision growth. Continued expansion of industrial/commercial use near Red Bluff and Willows, California is also expected.

In north central California, the development of recreational homes is expected to continue. It is also possible that timber harvesting will increase again there, as it has in northern Idaho.

It is possible that the Rio Vista Gas Field in the Central California Valley could be developed in the future; utilization of geothermal resources in the lava beds of

northern California and central Oregon is also a possibility.

West Coast (Los Angeles Leg)

Because the first 206 miles of the Los Angeles leg coincides with the San Francisco leg through Idaho and most of Washington, discussion of those two States appears above and will not be repeated here. Governmental entities with responsibilities for land use planning include the governments of the States and counties through which the proposed route passes. Planning by the U.S. Forest Service and the U.S. Bureau of Land Management also affects the area surrounding the proposed route.

All counties along the proposed route except two, Pershing and Nye Counties in Nevada, have established zoning, and most of them have a land use plan as well. Several counties are in the process of proposing more comprehensive land use plans. In California, where the State Code requires all counties to have such plans, land along the California portion of the proposed pipeline route is generally zoned under the broad category "Desert Living."

In Oregon, the potential of the Owyhee River for classification under the Wild and Scenic Rivers Act is being studied. In addition, the State of Oregon has identified the Grande Ronde and Malheur Rivers, including portions crossed by the proposed gas pipeline route, as needing State study to determine whether they should be included in the State Scenic Waterways System. Some areas of the public lands in California crossed by the proposed route have been proposed by the U.S. Bureau of Land Management (BLM) as California Desert National Conservation Areas; the route also crosses some BLM-designated Offroad Vehicle Areas.

In the foreseeable future the Blue Mountain area in northeastern Oregon is expected to show increased recreational use; growth of La Grande, Oregon, near the Blue Mountains, will probably continue. In the rest of eastern Oregon and the portion of Nevada crossed by the proposed route, the present mix of grazing, farming and timber harvesting will probably persist. In California, tourism and recreation use will continue to increase all along the proposed pipeline; increased residential growth and recreation use in San Bernardino County resulting from expansion of the metropolitan Los Angeles area will continue. Exploration and development of mineral and

geothermal resources in California could accelerate for at least the next 5-10 years.

2.OV.12 Paleontological, Archaeological, and Historical Resources

A. List of Known Sites

Executive Order 11593 and the Advisory Council on Historic Preservation Procedures (36 CFR 800) require that all cultural properties within the area of potential environmental impact be identified and evaluated both for determination of effect and for eligibility on the National Register of Historic Places. Table 2.OV.12-1 lists all historical and archaeological sites along the proposed route which have been identified as sites listed on the National Register of Historic Places or a State Register. The State Historic Preservation Offices of the States through which the proposed pipeline would pass have been consulted in identifying these sites. Not all known historical and archaeological properties have been evaluated for National Register status, properties are continually added to the Register, and unknown properties may be of a quality meriting nomination for Register status. Therefore, additional National Register properties which could be affected by the proposed route may be identified in the future.

Table 2.OV.12-1
Historical and Archaeological Sites Along Proposed Route Which Are Listed or Eligible for Listing on National Register of Historic Places or State Register

Location	Description	Distance from Pipeline (Miles)
Alaska		
Flaxman Island, mouth of Canning River	Leffingwell Camp	Not Given
Illinois		
LaSalle & Utica	Starved Rock State Park	0
La Salle	Illinois-Michigan Canal	0
Indiana		
Rensselaer	St. Joseph's Indian Normal School	1 1/2
Ohio		
Wapakoneta	Auglaize County Courthouse	2
Homer	Dixon Mound	Not Given
Morgan Center	McLaughlin Mound	Not Given
West Virginia		
Bethany	Old Main, Bethany College	1/2
Bethany	Alexander Campbell Mansion	1/2
Idaho		
Bonner's Ferry	Site of first ferry across Kootenai River (1826)	1
Sandpoint	Railroad depot	1.5
Washington		
Idaho-Washington border at Liberty Lake to Washington-Oregon border at Walla Walla	Kentucky Trail (1864-1872). Pipeline intersects route of Kentucky Trail approximately 1 mile northeast of Rosalia	0-5
Rosalia	Steptoe Battlefield. Col. Steptoe defeated by the Indians (1858)	1
Rosalia	Historic properties in town	1
Approximately 2 miles south of La Crosse	Texas Road (1865-1880)	0

Table 2.OV.12-1--Continued

Location	Description	Distance from Pipeline (Miles)
Lyons Ferry	Mullen Road (1859-1880)	1.5
Lyons Ferry	Marmes Rockshelter	1
Snake River pipeline crossing	Lewis and Clark Trail (1804-05)	0
Starbuck	Properties in town	3
Touchet River Crossing	Lewis and Clark Trail (1805-06)	0
Waitsburg	Historic properties in town	5
Spokane County	Turnbull-Pines Rock Shelter	Near
Spokane County	Horse Slaughter camp	Near
Oregon		
Morrow County	Oregon Trail (crosses ROW at 45°)	0
Milton-Freewater	Fremont's Route	Crosses
Deadman's Pass	Whitman Route	Crosses
La Grande	Oregon Trail	0-1.5
Crooked Creek Vicinity	Oregon Central Military Road	Crosses
Nevada		
Highway 395 at McDermitt	Fort McDermitt, established in 1865, longest occupied Army post in Nevada. Troops participated in California Modoc wars and Bannock Indian War	2
At Combination School in McDermitt	Memorial to Sarah Winnemucca Hopkins, daughter of Chief Winnemucca of the Paiute Indians	2
1.6 miles north of junction of Highways 95 & 8B	Early stagecoach stop called Paradise Well Stage Station	0
Smith Creek Ranch at Smith Creek	Pony Express Station	4.5
Berlin	Only site where fossilized remains of Ichthyosaur (a marine reptile) are to be found in the world	2.5
At approximate pipeline mile 800	Fremont Trail (1845)	0

Table 2.OV.12-1--Continued

Location	Description	Distance from Pipeline (Miles)
Fish Lake Valley	Ranch complex is a potential National Register property	3
California		
Modoc County	Bloody Point 1850 Indian/Settler Battle	2
Shasta County	Fort Crook site	1
Fall River Mills	Lockhart Ferry site	Not Given
Orland, Glenn County	Site of Swift Adobe, early homestead	5
Maxwell, Colusa County	Swifts Stone Corral early homestead	2
Winters Area, Solano County	University of California Experimental Farms	Not Given
Vacaville, Solano County 2 miles south	Vaca-Pena Adobe Hdqs. building, Vaca Grant Ranch	4
Independence	Putman cabin, first permanent habitation in Inyo County, 1861	4
Independence	Mary Austin's home	4
Independence	Edward's House	4
3 miles northeast of Independence	Fort Independence, established 1862	2
Kearsarge Station	Bend City Site, early settlement	Not Given
Keeler	Buildings in early settlement	7
Near Lone Pine	Cottonwood Charcoal Kilns	Not Given
State 190 at U.S. 395	Site where Jayhawker group of Death Valley 49'ers burned their wagons, 1849	0
North Lone Pine	Grave of 14 earthquake victims, 1872	2.5
15 miles south of Lone Pine on Cottonwood Creek	Colonel Sherman Stevens built a sawmill and flume, 1873	0.2
Olancha Creek near Olancha	First silver mill and furnace in Owens Valley, 1862	0.8

Table 2.OV.12-1--Continued

Location	Description	Distance from Pipeline (Miles)
Swansea	Owens Lake Silver and Lead Mill	6
Garlock	Early Town Site	Not Given
Cajon Pass	Important transportation route (pass)	0
Cajon Pass	Santa Fe-Salt Lake monument	1
Cajon Pass	Stoddard-Waite monument	1
West Cajon	Mormon Trail monument	1

B. Proposed or Planned Sites or Areas

C. Potentially Significant Areas or Sites

D. Background of General Areas Which May Indicate Future Discoveries

(1) Paleontological

Only a few sites where fossil remains of plant and animal life from earlier geological periods are known to exist would be crossed by the proposed route; there is, of course, the possibility of discovering additional sites during future investigations or excavations. In the vicinity of the Snake River in Washington, two paleontological sites, one 3 miles from the proposed route and the other 1.6 miles from it, are known. Also, the only site where fossilized remains of Ichthyosaur (a marine reptile) are to be found is at Berlin, Nevada, about 2 1/2 miles from the proposed route.

(2) Archaeological

Archaeological evidence indicates that some 25,000-30,000 years ago prehistoric people who had crossed the Bering Strait and the North Slope of Alaska used the Mackenzie River Valley as a southern migration route during

an interval in the glacial period when it was ice-free. Most evidence of prehistoric habitation, however, dates from a point beginning about 12,000-13,000 years ago after the glaciers receded; this generally holds true all along the proposed route, although some evidence along the San Francisco route suggests occupation may have occurred there as much as 20,000 years ago.

In the Alaskan and Canadian Arctic, prehistoric people were nomads and engaged in hunting and trading. Eventually they began fishing, both along the coast and along the inland rivers, streams, and lakes. In the Canadian provinces and in the lower 48 States, prehistoric man engaged in big game hunting in early times, ranging across broad areas. Gradually most groups became village based, traveling shorter distances to fish, hunt, or gather food and materials. The tools and weapons used by different groups varied in design; after prehistoric groups became more settled, they engaged in agriculture and produced more implements and other objects. Most settlements were located along rivers, streams, lakes, and other water sources. Villages varied in their permanency, as some groups, Indian groups in the Midwestern Plains for example, had to become hunters again because pursuit by other Indians and later by

whites forced them to move constantly. Use of the horse provided new mobility for these people.

The area along the proposed Los Angeles route south of the Snake River is rich in archaeological values, especially in the area of California traversed by the proposed Los Angeles route, which was relatively heavily populated in early times. The density of archaeological resources in this area of California is correspondingly high and it has been estimated that only 1/10 of the potential archaeological sites have been found. The Cajon Pass, where the Los Angeles route would terminate, is a prime area of interest because it is an age-old passageway from the Great Basin to the southern coastal area. The southern end of the proposed Los Angeles route also passes near the area where intercultural contacts between inland and coastal groups are believed to have taken place.

Along much of the route, relatively little actual archaeological investigation has taken place. However, an archaeological survey and excavations were performed along the Sagavanirktok River in conjunction with the Trans-Alaska Pipeline System project. In Canada, about 15 general historical and archaeological areas have been investigated in the North, and as part of a salvage proposal included in

the present application of Canadian Arctic Gas Pipeline Limited, 79 potential sites have been identified along the proposed route, all of them north of 60° North latitude.

Surveys have been performed in the Upper Missouri River Basin as part of the Smithsonian Institution River Basin Survey. In Ohio and Pennsylvania, professional investigations have identified a number of archaeological sites. Many sites along the proposed San Francisco route were identified as a result of construction of the Pacific Gas Transmission Company/Pacific Gas and Electric Company Gas pipeline completed in 1961. Substantial professional investigation of sites along the portion of the proposed Los Angeles route through California has also occurred.

Along the proposed route in Alaska, travel routes used by prehistoric peoples ran along the coast, and from the coast inland along the rivers or across the land in a southerly direction. One looks for evidence such as stone shelters, stone fences which served as caribou hunting blinds, limestone caves, and changes in tundra vegetation where dwellings stood. Eight areas have been identified as having potential archaeological importance; they include a seasonal campsite, an old village site, an abandoned trading post, trade routes, and a general area which served as a

trade meeting site. In Canada, one would expect archaeological sites to be found along the coast, the rivers, and lakes.

Along the proposed Northern Border route, a small number of known archaeological sites have been identified along the proposed route in North Dakota (3), Illinois (5), Ohio (3), and Pennsylvania (4); others are known in the broader study area surrounding the route. One site in Illinois, the Little Beaver Site, has been given high priority by the Illinois Archaeological Survey and is reported by the Applicant to be in the path of the proposed pipeline.

In the Plains portion of the Northern Border route, archaeological features to be found include tepee rings, bison kills, boulder effigies, trails, some wooden structures, and vision quest sites. As the proposed route passes east through the Plains, burial mounds which may be 2,000 years old are encountered. Artifacts to be found include stone and copper implements, pottery, and spear points. In Ohio and Pennsylvania, the archaeological sites found are mostly mounds, burial sites, and a few campsites.

Along the proposed San Francisco and Los Angeles routes, a large number of archaeological sites have been located; they include, besides the 2 sites listed on the National

Register, 29 sites identified as having known research potential. Many are in the path of the proposed pipeline and all are within 5 miles of it. The Marmes Rock Shelter is located on the Palouse River near the confluence with the Snake River in Washington and is 2 miles from the proposed route; it contains human remains and is the earliest known burial site in the Northwest.

Other archaeological sites along the West Coast routes include villages, campsites, fishing camps, water source camps, cave and rock shelters, burial sites, trails, sleeping circles and middens. Scattered flakes, grinding stones and cooking stones are found. Further south along the proposed Los Angeles route, pottery fragments, tools, stone enclosures used as antelope hunting blinds, petroglyphs, and pictographs are found. Important sites in the California portion of the Los Angeles route include Cottonwood Creek, the type of site for the Cottonwood projectile point series; Rose Spring, a deeply stratified site producing a relative dating technique through use of point types; the Stahl site, which has already yielded material approximately 3,000 years old, with evidently some of the oldest housing structures in the United States; and the Steam Wells Petroglyph site, which is in the path of the

proposed pipeline. The line would also pass over the extreme northeastern end of the Last Chance Canyon Archaeological District, which is on the National Register.

(3) Historical

There is little treatment of historical resources in the materials discussing Alaskan and Canadian Arctic. It is known however, that contacts and trade between the Native peoples and foreigners began in the 1820's when whaling vessels reached the Arctic Coast.

In the lower 48 States, the different parts of the country to be crossed by the proposed route have similar patterns of historical development. As the French Canadian traders and trappers entered the Midwestern Plains beginning in the middle of the 18th century, so the Spanish and the French sought to extend their influence in the Mississippi and Ohio River Valleys. In the Northwest, the early explorers were mostly British and American; in the Southwest, they were mostly Spanish and American. Battles between the military and Indians occurred in the mid-19th century, especially in the Plains and the Pacific Northwest; military occupation is part of the history of the Southwest.

In the Plains and in the West the miners, followed by farmers and ranchers, came in, producing a colorful history. Irrigation systems were developed in the West in the late 19th century, and the water wars are an interesting feature in southern California's history. The development of river travel, railroads, and famous East-West trades also expanded the Nation. Back in the Ohio River Valley, the development of river travel, canals, and especially the railroads facilitated the establishment of farms.

In Alaska, the Leffingwell Camp on Flaxman Island at the mouth of the Canning River is on the National Register. In the area of British Columbia to be crossed by the proposed route, there are a number of structures associated with the history of mining and railroad construction, such as early cabins, camps and mines, which require investigation and preservation. The proposed route would also cross two designated historical sites in Canada.

In the area surrounding the Northern Border route, the types of historical sites to be found include fur posts, historical Indian villages and camps, military forts, battlefields, dugouts, sod houses, homesteads, train depots, civic buildings, and canals. A small number of identified sites are located along the route in some States. In North

Dakota, the Fort Bouis Fur Post may be in the path of the proposed line. In Ohio, the proposed route would cross the Miami and Erie Canal one mile from a lock. Another segment of this canal is presently on the National Register; also, since canal portions containing locks are often added to State Registers, this portion might be designated in the future. In Illinois, 5 sites 1/2 mile or more from the proposed route but still close by are considered worthy of nomination for the National Register by the Illinois Historic Sites Survey. In West Virginia, one site nearby is considered worthy of nomination for the National Register by the West Virginia State Historic Preservation Officer.

In the West, many towns, battlefields, and ferries are historic sites. Trails and roads of historic interest are one of the principal historical resources. The proposed route would cross or parallel the Kentucky Trail, the Texas Road, the Lewis and Clark Trail, Marcus Whitman's route, John Fremont's routes in Oregon and Nevada, the Emigrant Trail, the Pony Express route, and the Overland State route. The proposed Los Angeles route would cross visible portions of the Oregon Trail 3 times near Meacham, and would roughly parallel visible portions of the Trail at distances of 1/4 to 5 miles for 65 miles from Meacham to Rye Valley. (This

is also the route of an existing gas pipeline of another company.)

(4) Unique Areas

In Alaska, 5 areas have been nominated by the Joint Federal-State Land Use Planning Commission for analysis as Science Research and Natural Areas; they are:

Prudhoe Bay

Jago River

Neruokpuk Lakes

Shublik Springs

Beaufort Lagoon

These would be for studies of unique vegetational and animal features. Also, the National Park Service is considering designation of 11 areas in Alaska as Natural Landmarks in order to preserve distinctive geological and ecological classes. They are:

Flaxman Island

Sagavanirktok River

Kadleroshilik River and Plain

Kadleroshilik Mound

Fire Creek

Sadlerochit Springs

Jago River

Clarence Plain

Demarcation Bay

Icy Reef

In Canada, a 2,140 square mile Firth River area adjoining Alaska's Arctic National Wildlife Range is proposed for establishment as an Ecological Reserve under the International Biological Program. The area contains archaeological sites and unique vegetational and wildlife features. Two other preserves are proposed in the Mackenzie Delta and Fort Norman areas under the same program.

2.OV.13 Recreational and Aesthetic Resources

Although aesthetic values apply to the entire countryside the relationship between aesthetics and recreation is a close one. Throughout the regions the proposed pipeline passes it is obvious that sites chosen for recreation areas are those sites with the greatest scenic or aesthetic values to be found in the vicinity. In some instances their aesthetic characteristics are of high enough quality to attract vacationers and retired people to come to a region to live. Within the scope of this pipeline corridor evaluation, the panhandle of Idaho falls within this category. One result of visitors coming to these areas is the establishment of new designated recreation areas such as parks, campgrounds and special use areas such as wild and scenic river designations or the creation of hiking and walking trails.

Alaska

The corridor in Alaska has no recreation developments occurring in its vicinity now. Much of the route lies in an area with high wilderness value. Studies are underway that may recommend that Congress consider including large areas

in the National Wilderness System. As access improves and knowledge of the area grows it is likely that people will flock to the region because of its wilderness character, unique scenery and high quality hunting and fishing opportunities. The short season, harsh climate and other problems such as mosquitoes and the high cost of housing and transportation all will be limiting factors for visitors. Because of the extremely fragile environment of the region, it will never be able to serve large numbers of people and still keep its attractiveness.

Canada

North of 60°N in Canada, both Federal and Territorial governments are examining areas with an eye toward establishing new national and territorial parks. Generally this region of Canada is one of the last recreation frontiers for both Canadians and Americans. Most of the countryside is true wilderness and is largely inaccessible, unpopulated and unknown. The problems for the recreationists above 60°N are very similar to those in Alaska, namely climate, lack of knowledge and high cost. Much of the countryside is rolling hills covered with low

profile vegetation. Closer to the Alberta-Northwest Territories border the conifers begin to appear and at the border valleys and hills are generally covered with conifers or mixed deciduous forest.

Recreation consists of "back country" type activities such as fishing, hiking, hunting, camping, nature study, photography and river floating. As in Alaska a major problem looms with the expected rush of recreationists, developers and tourists to the region. The problem is that the extreme sensitivity of the environment makes a balance with nature critical here. The severe climate and short season cause slow growth and slow healing of vegetation. Slow recovery is a regional characteristic. The high quality of fish in some lakes is already on the decline even with the limited pressure exerted so far.

In Alberta the pipeline route goes through the Chain Lakes Provincial Park and passes near to two other provincial parks. In addition, five Alberta and three British Columbia provincial forests are crossed. Hunting and fishing are major recreation activities and occur along the corridor in Alberta and British Columbia. Most big game and upland birds that occur in western Canada occur along the corridor. Several rivers also have recreational

floating, including whitewater, potential. Those that are best known also have historic values. Perhaps the most famous is the Rat River which served as a canoe route to the Yukon gold mining areas.

Southeast of Caroline Junction, Alberta where the Northern Border route begins its course to Delmont, Pennsylvania, the corridor enters into a country similar to northern Montana with the rolling prairie country predominating. No recreation areas are threatened by proximity to the pipeline although hunting and fishing are popular activities throughout the area.

Northern Border

The Northern Border route from Montana, where it enters the United States, to Delmont, Pennsylvania passes through lands used almost entirely for agriculture. To the west of Minnesota the grass-covered plains occasionally crossed by rivers and streams are the principal landscape features. Population is low; most people live in small towns. The region gives the visitor the impression of being largely undisturbed by man, with grazing the principal activity on most of the land. The clear, clean air is perhaps the most

noticeable feature of the environment. Only the Little Missouri Badlands, the site of Theodore Roosevelt National Memorial Park, are sufficiently unique and scenic to be worthy of national recreation designation. Other areas, such as the Killdeer Mountains and many stream crossings, are picturesque and provide the sites for the limited existing recreation activity other than hunting.

East of South Dakota to Central Ohio the pipeline corridor goes through the heart of the Cornbelt. The land is mostly cultivated with fences and occasional patches of woods or marshy areas being the only unplowed ground that provides cover for wildlife. Designated recreation areas are usually located along streams or, more often, in towns. Nine areas will either be crossed by the pipeline or be so close to the route that they can be expected to be affected in various ways such as blocking of access. Seven of these areas occur in the Midwest on the bank or rivers and the remaining two, in Pennsylvania, have small streams going through the parks that provide aesthetic values to the park. In the Midwest, the most important area along the Northern Border route in terms of recreational and aesthetic values is the Illinois River crossing where the Starved Rock Nature Preserve and State Park is located.

The nine designated parks along the proposed corridor currently experience over 3,000,000 recreation visits a year, about a third in the two regional parks just south of Pittsburgh and another third at Delaware Reservoir State Park north of Columbus, Ohio. Starved Rock State Park in Illinois receives over 600,000 visits annually.

Trails and waterways are a relatively new aspect of recreation in the Great Plains and Midwest that is growing very rapidly. Shade, water and good scenery are usually ingredients to these linear recreation areas. The twelve areas crossed by the pipeline vary from historical trails such as the Lewis and Clark, to an abandoned railroad right-of-way in South Dakota, to historic canals and rivers designated for canoe routes. Most of these areas are in various stages of being designated as official park and recreation areas, or in the cases of rivers such as the Little Missouri, Wapsipinicon and Wabash, as wild, scenic or recreation waterways.

West Coast (San Francisco Leg)

The corridor from the Idaho-British Columbia border to San Francisco follows the route of the pipeline laid in

1961-62. There are several deviations along the current route but most are only local adjustments. Most recreation in the region along the corridor occurs at the lakes and reservoirs near the route. The principal ones in the vicinity of the pipeline are Pend Oreille, Coeur d'Alene, Liberty Lake, Spirit Lake, Hauser Lake, and Lake Britton. In addition, several small lakes occur in the narrow Moyie River Valley in Idaho's panhandle. None of the lakes will be directly crossed by the pipeline and no facilities will be directly affected unless access should be temporarily interrupted, as at Black Butte Lake in California. Because so much of the countryside along or near the corridor is public land, campgrounds and picnic areas frequently occur. Most recreation on the public lands consists of hiking, nature study, fishing and hunting.

Recreational and aesthetic values in Idaho, Washington, Oregon and California are important to a large tourist business and in the Coeur d'Alene area to a booming retirement industry. Because of the low wooded ridges and valleys such as the Moyie which are tree covered, the cleared swath through the trees along the present pipeline is readily seen and is a serious detraction to the natural qualities of the region. River crossings along the route

will involve recreation and related scenic values. Of special note are the following: the Moyie River which is under consideration for inclusion into the National Wild and Scenic River System; the Snake River and Lyons Ferry State Park, a major access point for people living in Walla Walla; the John Day River, under study for National Wild and Scenic River designation; and the Sacramento River near Red Bluff, under consideration for National Wild and Scenic River designation.

Another area in Oregon near to the corridor is the lava beds near Bend. Two designated areas receive most of the visitation. They are the Lava River Caves State Park and Lava Butte Interpretative Center. More than 150,000 visitors per year visit these two sites. Both are very near to the pipeline route, the State park within 400 feet and the interpretative center within 4,000 feet.

Recreation is rapidly becoming a major business along much of the San Francisco route in all four States traversed. Private land owners, especially in Idaho and California, are converting their land to recreation use from other uses. At the present time population is small along the route except in the Spokane-Coeur d'Alene area and near San Francisco. As more people arrive to these and other

areas along the proposed route, more recreation areas are certain to be established.

West Coast (Los Angeles Leg)

The Los Angeles route parallels the San Francisco route for 206 miles to a point just south of the Snake River crossing in eastern Washington. North of the Snake River the Los Angeles route would require an additional 100 feet alongside of the San Francisco corridor. The necessity to have the wider corridor also makes necessary a wider cleared strip. In areas of timber such as the Moyie River Valley such an obtrusion would probably be the most noticeable feature in the valley. However, no additional recreation or aesthetic areas would be encountered by the widening of the corridor although Farragut State Park and its Wildlife Management area consisting of several thousand acres lie four miles east of the corridor on Pend Oreille Lake. This park and other recreation areas in the vicinity of the proposed pipeline probably will not be directly affected, but as the need arises to widen the corridor and add new pipes the aesthetic values in the vicinity of the corridor will continue to decline.

The Snake River's Lower Monumental Reservoir and other improvements will become increasingly important recreationally, especially for people in Walla Walla. Several recreation areas exist along the impoundments that serve as barge waterways. The pipeline comes closest to Lyons Ferry State Park and the adjacent Lyons Ferry Marina. The Snake River Gorge in Washington is identified in the Washington State Recreation Trails Program.

South of the Snake River the corridor passes through privately owned agricultural lands. Very few designated recreation areas are in the vicinity although primary access routes to recreation areas, especially in northwest Oregon, are either paralleled or crossed by the pipeline. In 1973 the State of Oregon published "Oregon Areas of Environmental Concern." Several areas identified are crossed by the pipeline or are close by. For example, segments of the Grande Ronde and Malheur Rivers are recommended for study for possible inclusion in the State Scenic Waterway System. In both instances these segments will be crossed by the pipeline.

The pipeline crosses many trails of historical interest in eastern Washington, Oregon and Nevada, the most important of which is the Oregon Trail. Considering the entire route

of the Oregon Trail the segment crossed by the pipeline corridor probably offers the best potential for establishment of scenic interpretative trails for hiking and horseback riding in areas of visible ruts. Much of the route here, as well as the adjacent landscape, appear virtually untouched since passage of the last emigrant wagon. The area historically is extremely sensitive.

In Nevada almost 90% of the pipeline crosses public lands, most of it managed by the Bureau of Land Management. No recreation areas are threatened by the project although off-road vehicle opportunities are great along the most of the route.

Further south in the high desert country of California the population centers of Los Angeles begin to influence the recreation activity. Driving for pleasure is very popular as the desert wild flowers and wildlife entice many thousands of people to visit the region during the spring. As in Nevada, no designated areas are so close to the pipeline that use would be affected. In California off-road vehicle use is a major recreation activity and areas have been established for this kind of use. Six of these areas are crossed by the pipeline corridor. Some facilities are in these areas but for the most part they are open country

tracts where the pipeline and recreation use should be compatible.

2.OV.14 Ambient Air Quality

Air inversion conditions are most prevalent in the Alaskan and Canadian Arctic, at the Mississippi River crossing, along the Northern Border route, all along the San Francisco route (especially in California), and along the Los Angeles route in mountain valleys (especially in winter) and in parts of Nevada. Ice fogs occur in Alaska and along parts of the proposed route through Canada where air inversion conditions combine with condensation nuclei produced by man-made machinery or certain natural sources. At the southern end of the Los Angeles route, smog spillover from Los Angeles is encountered.

The most severely polluted areas along the proposed route through the lower 48 States are Chicago, Columbus, Wheeling, Pittsburgh, Spokane, Sacramento and the Central California Valley, and portions of Nevada and southern California along the Los Angeles route. Federal standards for particulate matter, nitrogen oxides, sulfur oxides, carbon monoxide, and hydrocarbons have been periodically exceeded at locations along the proposed route; most of the measurements reported were for 1972 and 1973, with a decrease in concentrations in 1973 in some cases. Inversion conditions have probably contributed to high pollution

levels. High concentrations of particulate matter from natural sources have occurred along the western portion of the proposed Northern Border route, in northern Idaho and southeastern Washington, in the Central California Valley and all along the proposed Los Angeles route.

The San Francisco route Applicants, who operate an existing pipeline along the same route, state that nitrogen oxide and carbon monoxide emissions from the 16 existing compressor station turbines are small compared to local industries. Measurable quantities of sulfur dioxide and particulate matter are not emitted.

Alaska

Air quality in the Arctic has been monitored only at a few locations. At Prudhoe Bay condensation nuclei range from a background reading of 300 to 500 nuclei per cubic centimeter to 20,000 nuclei per cubic centimeter. High values are associated with close proximity to the Prudhoe Bay oil development industrial installations.

Winter arctic climate has a strong temperature inversion of 4,000 to 5,000 feet above the snow and ice surface that is caused by radiational cooling. It is only temporarily or

partially cleared by strong winds, and it reforms rapidly. Temperature inversions combined with condensation nuclei from industrial facilities associated with petroleum production and transportation may generate serious local ice-fog conditions. At Barter Island fog may be expected to occur on at least 74 days each year, and visibility is less than 1 mile about 118 days.

Canada

Data on air quality along the proposed pipeline route through Canada is generally lacking. Man-caused pollutants are minimal and probably consist mainly of vehicle emissions and dust from agricultural areas. Natural pollutants include such things as smoke from forest fires and seasonal pollen clouds from coniferous trees. In a few areas of southeastern British Columbia and adjoining Alberta, coal smoke occurs.

Pollutants are probably dispersed very rapidly along most of the proposed route. However where air inversions, most likely along river courses or in mountain valleys, combine with condensation nuclei caused by man-made

machinery or natural sources (such as respiration of migrating caribou herds), ice fog may develop.

Northern Border

Air quality generally declines from west to east in the 20 Air Quality Control Regions along the proposed route. The zones of most intense air pollution correspond to areas of highly developed industrialization. An emission density ranking of five polluting substances (particulates, sulfur dioxide, carbon monoxide, hydrocarbons, nitrogen oxides) with population density shows that all portions of the proposed route west of the Iowa-Minnesota area are relatively unpolluted. Severely polluted areas along the proposed route include the regions around Chicago, Columbus, Wheeling, and Pittsburgh. Only air particulates have been measured by all the States.

The western one-half of the proposed route receives air pollution from natural sources and plant combustion sources. There is good correlation between occurrence of sulfur dioxide and particulates with power plants and heavy industry, between hydrocarbons and carbon monoxide with automotive traffic, and nitrogen oxides with total

combustion sources. At times, nitrogen oxide concentrations exceed the National Standard of 100 $\mu g/m^3$ (micrograms per cubic meter). Periodic wind-generated dust appears to increase particulate concentrations in excess of 800 $\mu g/m^3$ in the farthest western part of the proposed route.

Excessive particulate concentrations occur locally in the eastern segment and sulfur dioxide concentrations greater than the National Standard, 80 $\mu g/m^3$, are observed along the route in parts of West Virginia.

The climate west of Indiana is highly favorable for dispersion of air pollution. Wind speeds are high and stagnant inversion layers do not occur except at the crossing of the Mississippi River. By contrast, the climate to the east of Indiana is conducive to stagnant inversion layers owing to generally low wind speeds in combination with mountainous terrain.

<u>West Coast (San Francisco Leg)</u>

The San Francisco leg passes through 7 Air Quality Control Regions. In Idaho and Washington, air concentrations of particulate matter periodically exceeded the primary Federal standards in 1972, the last full year

for which data was available; however, concentrations decreased in 1973. Naturally blown soil particles and lumber refuse burning are major contributors to high particulate matter concentrations; lumbering and saw mill activities also increase nitrogen oxide concentrations.

Spokane, Washington, and Sacramento, California, are the two areas along the proposed route that may be classified as "industrial"; in both cities, substantial automotive traffic results in nitrogen oxide, hydrocarbon and carbon monoxide emissions. Primary Federal standards for carbon monoxide and sulfur oxides were exceeded in 1972 and 1973 in the Spokane area.

In portions of the Central California Valley, secondary Federal standards for particulate matter and primary Federal standards for carbon monoxide and hydrocarbons were exceeded. The hydrocarbon concentrations in California are very high at all measuring stations, at times exceeding 10,000 micrograms per cubic meter.

The Applicant states that nitrogen oxide and carbon monoxide emissions from the 16 existing compressor station turbines are small compared to local industries, such as pulp and saw mills. Measurable quantities of sulfur dioxide

and particulate matter are not emitted from the existing stations.

The potential for air pollution due to air inversions is high all along the proposed San Francisco route; in parts of California, there is a potential for 80 days or more when air pollution can occur.

West Coast (Los Angeles Leg)

The Los Angeles leg passes through seven Air Quality Control Regions. The first 206 miles of the route coincides with the San Francisco route through Idaho and Washington, and discussion of that segment will not be repeated here.

In portions of eastern Oregon, secondary Federal standards for particulate matter were exceeded in 1972, the last full year for which data was available. In Nevada, primary Federal standards for particulate matter and sulfur oxides were exceeded. Along the lower part of the route through California, primary Federal standards for particulate matter and hydrocarbons were exceeded in 1972. At the southern end of the route, spillover of smog from the Los Angeles area is encountered.

Although there is a high likelihood of night air inversions along the proposed route, wind movements averaging 5 to 10 miles per hour prevent extended periods of air stagnation. However, in parts of Nevada there is a potential for 80 days or more when air pollution can occur. Inversions can be expected to exist much of the time, especially during the winter months, in mountain valleys similar to those where proposed compressor station sites 1, 5, 7, and 9 would be located, and can be expected some of the time at the other compressor station sites.

2.OV.15 Environmental Noise

Existing environmental noise levels are low along almost all of the proposed route of the Arctic Gas Pipeline System. In the Alaskan and Canadian Arctic, most of the area adjacent to the proposed route is undeveloped, with very little human population; background noise presently consists principally of the sound of wind, snow, and rain, sounds from oil field activities, and sound from infrequent aircraft flights.

Some of the land to be crossed in the Canadian provinces is also undeveloped; the rest is rural. Most of the lands to be crossed by the Northern Border and West Coast segments of the proposed route are also rural. In rural areas, background noise is mainly due to the sounds of wildlife, insects, wind, and rain. During the growing season, farm equipment is heard; a farm vehicle may generate from 80 to 90 decibels (db(A)). Highway traffic will be heard, intermittently in the less populated areas; one estimate of the daytime background noise generated at a distance of 250 feet by automotive traffic on a rural road is 45 db(A). Aircraft flights overhead will be heard, infrequently in the less populated areas.

For the Northern Border route, the Applicant has made ambient sound measurements at four proposed compressor sites, as shown in Table 2.OV.15-1.

Table 2.OV.15-1

Ambient Sound Levels at 4 Proposed

Northern Border Compressor Station Sites

Location	Day L_{10}	Day L_{90}	Night L_{10}	Night L_{90}
Morton County, North Dakota	33	28	30	28
Murray County, Minnesota	34	26	30	21
Near Erie, Illinois	39	28	42	28
Allegheny County, Pennsylvania	56	45	56	42

"L_{10}" means that the db(A) level shown is exceeded only 10 percent of the time; "L_{90}" means that the db(A) level is exceeded 90 percent of the time. The Environmental Protection Agency long-term environmental noise level goal is a 55 db(A) day-night average; thus average sound levels for three of the four test locations are very low, representing a quiet environment.

For the proposed San Francisco leg, the Applicants have made ambient sound measurements in the past at compressor stations along their existing pipeline. They do not report these measurements, but state that after construction was

completed, the sound level abated during the operational period at all but three of the 16 compressor station sites; at these 3 there was an increase in noise caused by the compression machinery. Supplemental silencing equipment was installed at 6 of the 16 stations because of nearby dwellings.

For the Los Angeles leg, the Applicants have not yet made ambient sound measurements along the proposed route. In Part IV, some estimated ambient sound levels have been provided on the basis of Environmental Protection Agency reports and rural data provided for the Northern Border Pipeline; these are shown in Table 2.OV.15-2.

Table 2.OV.15-2

Estimated Ambient Sound Levels

for West Coast Routes

Area	L_{10}	L_{90}
Rural-Desert	35-40	25-35
Rural-Near Highway	50-60	30-35
Near Communities (Rural)	60-70	45-50

The sound emitted by a source will be attenuated or reduced over distance at a rate which depends upon

environmental conditions. The environmental conditions that most commonly modify sound levels are topography, winds, and vegetation density. The worst case condition for attenuation is assumed to be no wind, with propagation over grass covered level fields for frequencies near 100 hertz. This is the frequency at which compressor noise and construction equipment noise is expected to be maximum. For this case the expected attenuation of decibel level is shown in Table 2.OV.15-3.

Table 2.OV.15-3

Estimated Sound Attenuation Over Distance,

Worst Case Conditions

Distance, Feet	100	200	400	800	1,000	2,000	4,000	8,000	10,000
Attenuation, db	0	6	13	19	23	32	44	62	70

Where the topography is hilly or mountainous, the attenuation rate may be accelerated or retarded depending on the topographic configuration. Under windy conditions, sound levels may attenuate or be reduced much more rapidly in a zone upwind, and concentrated in the zone downwind. Where woodlots or forest lands occur along the route, tree groupings can have a greater effect on the sound attenuation

rate than wind. Large stands of mature trees can be expected to increase the attenuation rate in Table 2.OV.15-3 above by an additional 5-7 db, provided the stand is 40 to 50 feet high, 100 to 200 feet in depth, and the receiver is 200 to 400 feet behind the stand.

In the Canadian provinces and the lower 48 States, the proposed pipeline would pass near farmsteads, some rural residences and, in the western States, ranches. It will pass near some public recreation areas and communities, the greatest concentration of these to be found where population density is greatest, along the eastern portion of the Northern Border route and certain portions of the two West Coast legs.

In South Dakota, the proposed line would pass near some waterfowl production areas; habitat for other wildlife species would also be passed by all segments of the proposed route. An Environmental Protection Agency report indicates that although little is presently known about the response of animals to noise, it appears that the major effect of sound levels commonly found outdoors is on those animals that use their hearing to detect their prey or their predators. Apparently, no studies have been made to determine the response.

In the lower 48 States, only a few States to be crossed by the proposed route, notably Illinois and Oregon, have strong State noise control regulations. Current legislation and regulations pertaining to noise control are shown for States crossed by the route in Table 2.OV.15-4.

Table 2.OV.15-4
Noise Regulations Along the Proposed Route in the Lower 48 States 1/

State	Laws or Regulations
Montana	Muffler law and law controlling noise from snowmobiles and motorcycles; proposed legislation (1973) would allow stationary noise standards on construction equipment and motor powered vehicles.
North Dakota	State Code permits adoption of standards on construction equipment noise and motor powered vehicle noise.
South Dakota	None.
Minnesota	Pollution Control Agency Law permits development of noise standards; standards have been proposed. 2/
Iowa	None.
Illinois	Noise Pollution Control Regulations adopted in 1973 limit noise emissions by dividing all land into 3 major land use classifications and setting maximum allowable noise emissions for each of the three classifications. 2/
Indiana	State Code provides maximum allowable noise emission standards for motor vehicles 2/; regulations also proposed for residential areas.
Ohio	Proposed legislation would give a tax exemption to that part of a facility used exclusively for air or noise pollution control.
West Virginia	None.
Pennsylvania	State law controls noise emissions of motor vehicles 2/; State Department of Environmental Resources guideline establishes definitive sound level emission standards for community noise; State Code allows Occupational Safety and Health Act noise levels to be enforced at State level; proposed legislation (1971) would permit development of regulations to abate nuisances, including noise.
Idaho	State has general code covering horns, warning devices, and use of mufflers.
Washington	State noise control act permits development of performance standards which would cover compressor stations; none issued thus far.

Table 2.OV.15-4--Continued

Oregon	In accordance with State noise control laws, State has issued comprehensive set of noise control regulations which limit noise levels of trucks and stationary sources including compressor stations. 3/
California	State regulates noise levels of motor vehicles.
Nevada	State law provides for motor vehicle noise regulations but none have been established.

1/ Excluding State general public nuisance laws and nonspecific muffler laws.

2/ See specific standards in Part V (Northern Border).

3/ See specific standards in Part IV (West Coast).

3.OV Environmental Impacts of the Proposed Project

The proposed natural gas pipeline system would involve some 6,000 miles of steel pipe originating on the Arctic Coast of Alaska and extending to southern California and western Pennsylvania. It would cross arctic tundras, subarctic boreal forests and muskegs, temperate coniferous forests, hardwood forests, grasslands, and the deserts of the Great Basin. It would cross mountains, rivers, lakes, reservoirs, highways, and railroads. The impacts of building and operating a pipeline system in such a diverse environment are themselves diverse and are discussed at some length in the volumes of this Environmental Impact Statement covering the various segments of the proposed transmission system.

In this overview the impacts of the proposed action are summarized and discussed in the context of the total system.

3.OV.1 Climate

Construction, operation, and repair of the proposed natural gas pipeline system would have no effect on regional climate, but some micrometeorological changes and some local changes are anticipated. The changes would range from serious local ice fog problems around compressor stations to microclimatic changes directly above the pipeline.

Compressor station turbine exhaust emissions of some 7,200 gallons of 600°F water vapor per hour would affect the climate immediately adjacent to each compressor station in the arctic areas of Alaska and the Yukon. The proposed project would require initial construction of 19 compressor stations. There would be an initial compressor at Prudhoe Bay, 2 between the International Boundary and Travaillant Lake Junction, and 16 between Travaillant Lake and 60° N. The initial compressor station would have a 15,000 horsepower turbine in addition to the 30,000 horsepower turbine that would be at the other compressor sites. The vapor problems would therefore be worse at the initial station. Under certain conditions this water vapor would result in the formation of ice fog at these sites. Local meteorological conditions conducive to the formation of ice

fog are a temperature below -22° F accompanied by a temperature inversion and low wind velocity.

The impact of this ice fog would be site-dependent. In isolated areas it would result primarily in operational problems, resulting in interruption of traffic flow, and wear on turbine blades. The environmental impact would not be great or effect a wide area.

Sixteen of the compressor stations would require mechanical refrigeration equipment. These chillers could cause additional local micrometerological change through additional vapor discharge and local temperature change. Climatic impact is expected to be minor.

During early operating phases the San Francisco and Los Angeles pipelines would not be operated at capacity; gas within the pipe would be cooled through heat drop as the gas expands. A similar temperature drop would occur on the pipeline to Pennsylvania. Reduced soil temperatures would result in lower air temperatures directly over the pipeline. As compressor stations are added to increase the capacity of the lines the temperature of the gas in the line will be raised. The ultimate result will be higher air temperature directly over the line. The microclimatic change coupled with the altered soil temperature regimes could result in

alteration of the species composition of plant and invertebrate communities above the pipeline. The impact would be minor.

Winter darkness, extreme temperatures, strong winds, and blowing snow all interact to make construction activities hazardous in the arctic environment. The pipeline would be built across the Arctic Coastal Plain in the winter to take advantage of the firmly frozen ground at that time of the year. In the tundra and the northern boreal forest permafrost regions, the winter freezeup makes travel easier while pipeline excavation is no more difficult in winter than in the summer. Winter frost conditions on other segments of the line, however, will make winter pipeline excavation more difficult. Frost 40 to 70 inches deep would be encountered in northern segments of the three pipelines in the lower 48 States.

3.OV.2 Topography

Construction of the proposed pipeline system would change the character of the terrain in many local instances, modifying its contours and dimensions. Cuts and fills created in leveling the right-of-way, access roads, borrow pits, and spoil piles all will have impacts on the topography which will vary with their location and scale.

Wind erosion of disturbed soils, particularly in sand dune areas, and gully erosion following construction will change the topography and also cause secondary impacts by transporting the soil to other locations. In open tundra and grassland landscapes, the pipeline ditch berm, gravel road and airfield embankments, and the various buildings and towers will create new elevations and a new horizon alien to the natural topography.

3.OV.3 Geology

The proposed pipeline system would have no significant impact on the bedrock along the route. In Alaska and northern Canada, however, construction and operation of the pipeline system would have an impact on mineral resources. The installation of the pipeline and its associated airfields, roads, and communications network would stimulate prospecting and development of additional oil and gas reserves and mineral deposits in the Arctic.

Operation of the line in Montana and North Dakota would stimulate the development of coal deposits there for possible gasification and transmission through the pipeline.

Geologic phenomena at various locations along the routes would affect the construction and operation of the pipeline system. The most important of these phenomena in the North is permafrost which ultimately controls all construction practices and design in the Arctic. Permanently frozen ground is topped by a zone near the surface which thaws each summer. Water flows and biological activity occurs in this "active layer." Activities that increase the depth of the active layer lead to slope instability, erosion, sedimentation, and failure of manmade structures. The proposed pipeline will be buried in permafrost and the

construction will disturb the active layer, with resulting secondary impacts on vegetation, soils, and water quality.

At the southern end of the system, the pipelines to San Francisco and Los Angeles are located in areas of high seismicity and major damage to the pipeline system is likely in the event of a major earthquake. Pipeline failure might be caused by (1) ground shaking, (2) displacement along a fault, or (3) secondary surface displacement due to shaking. The Los Angeles pipeline route passes through the Owens Valley where quakes with a Richter magnitude of 7 are possible, and terminates 3 miles from the San Andreas fault which is thought capable of Richter magnitude 8 to 8.3 earthquakes.

On those two routes, intense flash floods are likely to occur more often than earthquakes and could cause severe damage to the pipeline system from scour of streambeds, movement of large boulders onto the pipe, etc.

Landslides might be induced at many places on any identified route if slopes were undercut while the pipeline ditch was being excavated. The slides could cause immediate damage and/or loss of life or they could occur at a later time and possibly rupture the pipe.

3.OV.4 Soils

Construction of the proposed 6,000-mile gas transmission system will have significant impacts on soils along the various routes. Disturbance and mixing of the soil profile will alter its structural characteristics, microbiological activity, and the soil-climate relationships. This mixing of subsoil on the surface of the backfilled ditch will prevent the full restoration of the site and cause a permanent loss of soil productivity. On the Los Angeles route alone this would cause a loss of natural soil productivity on 14,000 acres, including 2,800 acres of agricultural cropland and 1,300 acres of forests. Crop growth and grazing capacity would also be reduced on the other routes, with the impacts depending on the soil type. In all cases the pipeline excavation will be well below the topsoil depth, since the ditch will be 7 to 10 feet deep. Topsoil horizons vary from a few inches to 2 feet along the various routes. An estimated 300 miles of the Northern Border route would be left with relatively sterile subsoils or parent materials on the surface.

Wind erosion of exposed soils along the ditch would be a major impact where detached fine silt and clay particles are exposed. An estimated 17,000 tons per year could be lost by

wind erosion on the Los Angeles route between Spokane and the Oregon border. Wind erosion hazard would also be high along the 650 miles of the Northern Border route across the spring wheat region of Montana and North Dakota where losses could be as high as 53 tons of soil per acre per year. Losses exceeding 5 tons per acre per year from wind erosion would cause severe seedling damage and make revegetation of the right-of-way very difficult.

Water erosion would form gullies and increase sediment yield from the disturbed soil on all routes. Erosion hazard is greater on certain soils. For the Northern Border route the high hazard mileage is estimated as shown in Table 3.OV.4-1.

Table 3.OV.4-1

Miles of High Erosion Hazard

Soils, Northern Border Route

State	High Hazard	Soil Losses, tons
Montana	38	20,520
North Dakota	120	65,800
Illinois	2	2,800
Ohio	100	114,200
West Virginia & Pennsylvania	40	26,500
Remaining slight to moderate hazard	1,275	153,000
		381,520

The Northern Border route would also cross three irrigation project areas in Montana and North Dakota. The ditch and gas pipeline would interfere with subsurface and surface irrigation drains. Construction equipment and compaction would disturb the soil density and slope and interfere with gravity flow irrigation.

From North Dakota east to Pennsylvania the proposed gas pipeline would transect thousands of miles of farm drainage systems. Pipeline ditching would cut these drains, introduce sediments, and possibly pollute the receiving streams.

Without functioning drainage systems, farming would be very difficult.

3.OV.5 Water Resources

Construction and operation of the proposed natural gas pipeline system would present potential water resource impacts at each stream crossing from erosion and sedimentation, and from introduction of industrial chemicals and pollutants.

Hydrostatic testing of the completed pipe will require huge volumes of water, and the indiscriminate use of surface waters for test fluids may reduce local flows and quality. Test-water discharges may be colored and have high iron oxide or other metal content which would lower quality of receiving waters and may form a reservoir of metals toxic to aquatic organisms. Disposal of water from purification columns at Prudhoe Bay, if a wet adsorption process is used to remove carbon dioxide and hydrogen sulfide from the gas, must be provided.

Water supply is a significant problem in the Arctic where most surface water will be frozen during the construction season. Indiscriminate withdrawal of water from springs and lakes will have severe adverse effects on overwintering fish and invertebrates.

Release of large volumes of test water into dry stream channels on the western routes would cause streambed scour, erosion, and increased sediment yields.

Erosion from construction sites would cause a temporary reduction in downstream water quality, as would the use of large volumes of domestic water and discharge of sewage at each construction camp. The Los Angeles route passes so close to a municipal water well serving Johannesburg and Randsburg, California, that it could contaminate the supplies of these towns.

Fuel and lubricant spills from construction machinery, compressor stations, camps, etc., would pollute surface water and groundwater supplies. Huge volumes of fuels will be stored and used at each camp and some spills are inevitable.

3.OV.6 Vegetation

Vegetation and terrain surface integrity will be totally destroyed along the pipeline ditch, at camp and landing sites, towers, permanent roads, and other permanent facilities. Vegetation will be partially destroyed and changed by winter roads; alteration of drainage; forest, grass and tundra fires; fuel and methanol spillage; sulfur dioxide emissions; and off-road vehicle use for pipeline emergency repairs. A number of proposed ecological preserve sites will be paralleled or crossed, thereby greatly reducing if not destroying the purpose for which they were set aside. Invasion by weedy plant species is expected to occur in the denuded areas, particularly on land managed for wildland or forest.

Fires characterize forested areas and also extend into tundra and grasslands. The incidence of fire will probably increase during the construction and operation of the pipeline, especially during summer activities, but so should the ability to detect and control fire.

Where the pipeline crosses forests or woodlands, there will be a permanent change in vegetation, because in no case will forest or woodland be allowed to grow directly over the line. Cropland production loss will be considerable while

construction is underway, but will be back to near normal within a few years.

With a successful revegetation program along the route, primary production losses will occur for only a few years. This will, however, cause some long-term changes in vegetative plant communities.

3.OV.7 Wildlife

The proposed natural gas pipeline would affect a wide range of wild species. Effects will range from short-term beneficial (new "edge" effect mode) to long-term adverse (destruction of critical habitats).

Mammals

Areas of critical mammalian habitat that would be affected range from caribou calving grounds in Alaska to Indiana bat caves. These areas will be affected by clearing vegetation for rights-of-way and project-related facilities, by pollutant spills, and by continued suppression of trees and brush during the operation phase.

Impacts on mammalian species would range from insignificant to potentially very serious. The greatest changes would occur in arctic and subarctic areas which are the least altered presently.

Habitat for small mammals would be altered permanently within the pipeline corridor in undeveloped areas. This habitat alteration would be insignificant in the areas where the habitat loss would be small in comparison to the total

available habitat. It could be more serious in areas where little natural habitat remains.

In the Canadian territories and in northeastern Alaska where wildlife and its environment is still in a harmonious balance approaching the primeval condition change cannot be avoided. Causative factors would be habitat disturbance, pollution and an increased human presence. The impact is hard to quantify. In many cases it would be inversely related to the amount of care taken to avoid impact.

Caribou, particularly those caribou in the internationally ranging Porcupine Caribou Herd, face the greatest potential for serious impact. The section of the pipeline which would cross the Arctic National Wildlife Range would bisect the calving ground. In Canada vastly enhanced access to the winter range would greatly increase hunting pressure and other human disturbance on this historically lightly hunted herd. Disturbance from activity directly associated with construction and operation of the proposed pipeline coupled with potential physical and psychological barriers to caribou movements which could result from the construction of the pipeline and associated facilities could result in long-term impacts. Calef (1974) suggests that the combined impacts could result in a 90%

reduction in the herd within 5 to 10 years unless these impacts are substantially dampened by strict adherence to properly designed mitigative measures.

Birds

Impacts on birds could cover a wide range from insignificant to severe. Impacts would be relatively insignificant in developed areas and more severe in arctic and subarctic areas.

In the prairie pothole region, particularly in the Dakotas and Minnesota, important breeding habitat would be lost through dewatering or silting in of potholes resulting from pipeline construction. The impact would be locally significant.

On the relatively undisturbed northeastern portion of the Arctic Coastal Plain and in the Mackenzie Delta area relatively severe impacts are possible. Aircraft movements, construction activities and human presence would be the principal sources of impact. The potential for serious impact is greatest with snow geese staging for fall migration on the Arctic Coastal Plain. Snow geese are particularly sensitive to disturbance by aircraft. They

will flush as far as nine miles from a low-flying aircraft. Repeated exposure to this disturbance is critical because it limits the storage of energy necessary for migration.

Active airfields, compressor stations, and maintenance camps could effectively deprive nesting Canada and white-tailed geese of nesting habitat up to a radius of 2 3/4 miles around the perimeter (or air traffic pattern) of each site. While the impact at each site would be minor in relation to the total available habitat, there would be a cumulative long-term loss in reproductive capacity.

Habitat destruction from water quality degradation through pollution and increased silt loading, vegetative change or destruction, changing drainage patterns, and drainage of water courses will all adversely affect bird populations.

Fish

Environmental impacts on fish would be local and could cover a full range from insignificant to serious. The impacts can be expected to be most serious in the remote areas where previous development has been slight. Impacts would stem from eight primary sources:

1) enhanced turbidity

2) elevated suspended sediment loading

3) temperature degradation

4) stream dewatering

5) enhanced BOD (biological oxygen demand)

6) loss of spawning gravels

7) alteration of other physical conditions

8) pollution

One of the most serious impacts would be increased sediment loading. This could result from a number of activities and causes. Cutting of stream banks and trenching in stream bottoms during construction would result in immediate increases in sediment loading. The impact would be dependent upon the stream and the season. There would be less impact in a stream where turbidity and heavy suspended sediment loads are normal than in clear water streams or during clear water seasons.

Enhanced sediment loading could be anticipated for several years. It would stem from erosion of areas where vegetation was disrupted during construction, from altered drainage patterns and from enhanced mass wasting.

The frost bulb around the chilled pipeline would act as an ice dam blocking the groundwater flow in the alluvium

under arctic streams. Very serious aufeis (icing) problems could be anticipated when this occurred. Extensive aufeis areas can persist throughout a summer season. Water temperatures in a stream would be significantly depressed below a large aufeis area, 5.5° C in one case (Craig and McCart, 1975). This could result in thermal barriers to migration or cause a spawning area downstream to become unacceptable or unproductive because of the depressed water temperature. Alteration of the direction of stream flow so that degradation of an ice lens would result could have the same effect.

Another consequence of the frost bulb around the chilled pipeline creating an ice dam is the dewatering of a stream below a crossing. Construction and camp water demands can produce the same effect. During the winter of 1974-75 complete dewatering of sections of the Sagavanirktok River appears to have occurred several times. This was the result of the taking of water for oil field operations. The demand during construction of a gas pipeline would probably be even greater. The streams faced with this demand would be even smaller than the Sagavanirktok River. The impact on fish in these streams could be serious.

Mass wasting or erosion of the active layer or ice-rich soils with a high organic content would result in an enhanced BOD (biological oxygen demand). This could have a serious impact particularly on overwintering fish. Depletion of oxygen when coupled with the concentration of fish by partial dewatering would be extremely serious. Discharge from camp sewage plants would cause increased BOD also, with similar results. Drainage of fertilizer from reseeded areas is another source of increased BOD.

Active flood plains are the primary source of gravel in the Arctic. Gravel taken from spawning areas would result in loss of these spawning areas.

Water passing over an ice dam during the summer would create a hole downstream. The impact from this hole building could be positive or negative. In a stream with uninterrupted winter flows this could create new winter habitat for fish. In streams with a potential for dewatering this would create a fatal trap for fish.

One aspect of organic pollution already touched upon is an increased BOD. Pollution around construction areas will take other forms as well. Spills of petroleum products, methanol and other chemicals can be anticipated. The use of pesticides in the construction area would result in

pollution in the watersheds draining the sites. Impacts on fish would result. The degree would be situation-dependent.

3.OV.8 Ecological Considerations

Clearing, excavation and construction activities for the proposed natural gas pipeline system would disturb some 75,000 acres in a strip 100 to 120 feet wide and 6,000 miles long. The several routes would cross arctic tundras, subarctic boreal forests and muskegs, temperate coniferous forests, hardwood forests, grasslands, croplands, and the deserts of the Great Basin. Pipelines would cross mountains, rivers, lakes and reservoirs.

Complexities of processes and interactions within ecosystems make it difficult to predict the impact of the proposed pipeline system on the many ecosystems involved. Experience has shown, however, that the indirect consequences are potentially more significant than the direct and more obvious ones.

Disturbance by wind and water of the organic cover protecting soils from erosion, and the mixing of topsoils with subsurface materials will adversely affect the functioning of all terrestrial ecosystems and result in reduced productivity. This reduced productivity will occur in the disturbed areas of croplands as well as wildlands and, in many soils, cannot be restored by application of fertilizers.

Where the proposed route passes through areas which are largely cultivated and shaped for man's use there are still some small scattered remnants of natural habitat. These scattered woodlots, brushy gullies, fringes of bottomland hardwoods and other nearly natural areas provide a diversity of landscape, vegetation and wildlife habitat within the cropland ecosystems essential to the production of wildlife. Destruction of each additional increment of these few remaining natural areas will further reduce the diversity and abundance of wildlife available to man in the settled areas of the country.

The prairie pothole region contains a very special ecosystem which provides the cover and nutrition required by many waterfowl and shorebirds at critical periods in their life history. Pipeline system intrusion on this ecosystem, already decimated by agricultural drainage, will affect migratory bird populations covered by international treaties with Canada and Mexico.

Turbidity and sedimentation created at stream crossings will result in a reduction in primary productivity of the affected streams which should last only one season unless erosion of the disturbed areas continue to contribute silt to the stream.

In summary, pipeline construction will cause locally significant losses in net annual productivity, but in relation to the size of most ecosystems affected, the losses will be minor. Some reduction in the diversity of native plants and animals will be accompanied by an increase in the numbers of "weed" species.

3.OV.9-10 Socioeconomic

Many of the impacts of the proposed pipeline will be beneficial to the socioeconomic resources of the areas through which it passes.

During the construction phase, tax benefits to State and local governments along the pipeline corridor will come primarily from sales and motor fuel taxes. Personal and corporate income taxes will also generate revenues to the States. Additional revenues to State and local government will be generated by State and local sales and income taxes where they apply. Property taxes on the pipeline, compressor stations and improvements will be the primary tax benefits to the governments through whose jurisdiction the pipeline passes. New housing and business expansions resulting from the needs of new permanent employees would add to the local property tax base.

Alaska would have an additional benefit from the sale of its royalty interest (12.5%) of the natural gas produced there.

Adverse impacts would come about because of short-term surges of demand for housing; demand for Federal, State, and community services; cultural upheaval; and increased

competition for recreation, education, transportation, and entertainment.

Impacts will be felt more intensely in small communities and counties with small populations. Areas with large populations will be better able to absorb the influx of construction workers than areas with smaller ones.

Production will be destroyed from agricultural and forest lands throughout much of the route. Some of the land will be out of production for only a short time but other lands will be out of production for the life of the project.

3.OV.11 Land Use

The route of the proposed project traverses substantial portions of agricultural lands from southern Canada to the midwestern and western parts of the United States. The pipeline right-of-way will impact the agricultural use during the construction period. Those lands required for use of compressor and pumping stations, new roads, and other permanent facilities needed for the operation phase of the project will be lost to agricultural use for long periods of time. Soil disturbance could have long-range impacts upon the productivity of some types of farmlands, but use for pipeline purposes will not preclude use for agriculture.

In those parts of the country where irrigation is used in conjunction with agriculture, a new set of impacts is found, such as the problem of interference with irrigation and drainage ditches.

Livestock grazing would be much less impacted than row crops due to various factors such as fertilization and soil compaction which are more important in raising row crops.

The pipeline will traverse large areas of forested lands, both commercial and non-commercial. In the commercial forested areas there will be a long-term loss of timber production. There would also be about 20 to 25 miles

of commercial orchard lands impacted in California. During the construction phase a swath of about 100 feet would be cleared of all trees and during the operation phase about 50 feet will be maintained free of trees. Many areas of important woodlands in the Midwest will be impacted. Compressor stations, communication towers, mainline block valves, delivery-measuring stations and access roads will remove areas from timber production and from all tree growth.

Residential, commercial and industrial land uses would be precluded from the pipeline right-of-way and from sites of related facilities. Many of these rights-of-way and sites are located in the vicinity of communities and railroad sidings throughout the route system. While the total area involved is not significant, the linear nature of the project makes it difficult to avoid key areas.

The proposed project will also impact existing and potential oil, gas, coal and other mineral development. There is a possibility that the existence of a transportation system would stimulate an increase in further exploration and possible development of potential oil and gas basins in northern Alaska and Canada as well as the coal field in Montana and other parts of the U.S. The impacts

from this aspect can be major and of national significance. Additional oil and gas deliveries to various parts of the country could help ease the energy shortage while the development at the source could involve ecological consequences of major proportion. An energy source close to metal-bearing formations could aid in the recovery, refining and transport of products to market areas.

The proposed project if implemented would impact a wide variety of existing Federal, State, county, municipal and local management areas. Management plans for many of these areas do not identify the need for gas pipeline rights-of-way and indeed such use could severely impact the basic values and integrity of the unit. State and Federal parks, wildlife refuges and management areas, forest and grassland areas would be involved. Impacts on the existing plans would vary from major, as with the Arctic National Wildlife Range, to slight.

The proposed project would impact a wide variety of existing transportation and communication facilities. Major highways, secondary roads, railroads, navigable rivers, canals, power transmission lines and other pipelines would all be crossed or closely paralleled in places along the prime route. The construction phase can increase the

traffic on existing systems, and in some cases there will be a need to halt traffic to install the pipeline beneath the existing surface. Traffic delays can be expected in some areas due to the slow-moving vehicles traveling along, entering or leaving the highway. Increase in traffic can be expected from construction crews commuting to and from work, and by trucks hauling pipe, test water, fuel and other materials.

The proposed route crosses many buried and overhead transmission facilities. These facilities can suffer damage if good, safe construction practices are not followed.

All known underground facilities such as gas, petroleum products, telephone, water and sewer lines must be located prior to trench excavation. Care must be taken when exposing these lines during excavation and to adequately support these lines while the pipeline is laid underneath these lines. Damage to certain types of lines can cause property damage, pollution and death.

Damage to overhead lines will not occur if good, safe practices are followed. However, equipment can damage poles or towers and can cause damages if it comes in contact with the overhead lines. Contact with power lines can cause

damage to equipment, injury or death of workmen and disruption of service to customers.

Planning for comprehensive land use is under way in most of the counties crossed by the proposed pipeline. Many governmental units are represented: Federal, State, county, and city. Planning and zoning steps have been taken in varying degrees. However, the significant point with regard to this proposal is that there is no existing mechanism by which this complex set of governmental entities can coordinate planning efforts to even recognize (much less fully consider) a proposal of this size which stretches 1,100 miles from Alaska into California and Pennsylvania.

Formal land use planning in the States along the pipeline is in the early stages of development. State legislation that creates authority and staffing for statewide land use planning and controls has not occurred in any of the States. Section 2.OV.11.E-F in this overview summarizes the status of land use planning efforts. Land use mapping and zoning authority are two activities leading to land use planning that are gradually becoming planning tools at the county level. Perhaps the greatest problem at this time for most counties is the lack of adequate funding and staffing.

The impacts on land use planning resulting from the construction and maintenance of the pipeline will be variable. Compatible uses of lands on the right-of-way and adjacent lands, especially near compressor stations, will result in some restrictions on land use. Because most of the land in the corridor consists of grazing and cultivated land, little change of use is anticipated.

3.OV.12 Paleontological, Archaeological and Historical

The nature of the proposed construction is such that any cultural resource sites in the path of the pipeline, access roads, compressor stations or other facilities will be damaged or destroyed. In most cases the damage would be a direct consequence of site disruption and excavation by man and machine without knowledge of the paleontological or archaeological values, but in other cases the impact will come as a consequence of increased access and vandalism to unprotected historic sites.

There are now enough sites of known historical and archaeological value along the various proposed pipeline routes to practically guarantee that additional sites will be encountered. Such sites are finite non-renewable resources and their destruction would have a long-term irreversible impact since the materials lost would not be available for the interpretation, education, and enjoyment of future generations.

Very little is known about the pre-history occupation of the Arctic Coastal Plain by man, but the coast and several of the rivers appear to have been trade routes where archaeological sites might be found. If the pipeline is constructed as proposed during the cold and dark arctic

winter, discovery, protection and recovery of sites will be very difficult.

Fifteen known archaeological sites are threatened by the proposed Northern Border pipeline route and five of these (in North Dakota, Illinois, and Pennsylvania) are likely to suffer major damage. The route would also cross historic canals in Illinois and Ohio.

The pipeline route to San Francisco would cross 8 historic trails, while 7 historic and 21 archaeological sites would suffer direct damage from the construction. Potential impacts on historic and archaeological sites are judged to be high on 364 miles and medium on 754 miles of the route to Los Angeles.

Sites discovered and properly investigated prior to construction would add to the knowledge of our heritage. Some sites might be located during construction that could have enough interest and significance to warrant permanent protection and become points of interest and public attraction.

3.OV.13 Recreation and Aesthetics

The Arctic Slope of Alaska and the Yukon Territory is largely wilderness at this time and the proposed pipeline with its associated transportation and communications facilities would introduce not only machinery and noise, but also more people to the area. The presence of more people, even fellow recreationists, will have a long-term detrimental effect on resources which are becoming more scarce each year--wilderness, solitude, and quiet.

Pipeline system buildings, radio towers, airfields and other facilities will continue to alter the aesthetic quality of the Arctic Slope during the life of the pipeline. Vapor plumes from the compressor stations will stand out on the level arctic terrain and be visible for miles. Compressor station noise will persist throughout the lifetime of the pipeline system and airplane patrol flights will be seen and heard by people who may not otherwise notice the pipeline operations.

The cleared and disturbed pipeline right-of-way will be a discordant element in the tundra and boreal forest vegetation for many years and will show up as a long, straight line with a color and texture different from the surrounding landscape.

The relative significance of an impact on aesthetics depends on the inherent quality of the landscape, the number of viewers, and their sensitivity for the landscape being observed. Visual impacts will be most apparent in forested areas and in open range or desert country, while the impacts in agricultural and industrial areas will be much less. Depending upon the particular landscape's variety and sensitivity, the impact of the proposed pipeline will be significant, moderate, or slight. Some 196 miles of the 1,119-mile-long route from Kingsgate, B.C., to Cajon, California, will suffer significant aesthetic impacts. About 46 miles of the 911-mile route to San Francisco would suffer significant aesthetic impacts. That proposed line would be parallel to an existing gas pipeline constructed in 1961 and few new recreation or aesthetic impacts would result.

The proposed Northern Border pipeline route would cross 10 designated park and recreation areas and 12 recreation trails or waterways. One waterway, the Wabash River, is a candidate stream for a State recreation river system. Most impacts on recreation use would be short-term ones disrupting use of each area during the construction period. Impacts on the many areas with special aesthetic values

would be longer-term, and may be greater in the public-use areas than in more remote sites.

The loss of old trees, straight-line cuts through mature forests, and pipelines ascending steep bluffs and cliffs will all constitute aesthetic impacts of long duration.

Pipeline construction access roads will provide public vehicular access in previously inaccessible areas of Oregon, Nevada, and California with concurrent impacts on the recreation user and land manager in those areas.

3.OV.14 Air Quality

The only continuous long-term impacts on air quality would be from the operation of the many compressor stations along the gas pipeline system. Turbine exhaust emissions would contribute both unburned hydrocarbons and various combustion products which, due to the exhaust stack height, would be most concentrated in areas about 1/2 to 1 mile from the stack. In terms of effects on human health, nitrogen dioxide would be the only significant pollutant emitted from the compressor stations. Nitrogen dioxide concentrations may be created that are dangerous to human health around compressor stations when atmospheric conditions combine to prevent dispersion.

Sulfur dioxide emissions, while low enough to preclude adverse effects on human health, would be present in sufficient concentrations to kill lichens which are very sensitive to sulfur oxides. Loss of lichens would impoverish the flora near compressors, and would have adverse impacts on caribou dependent on those plants in Alaska and Canada.

Concentrations of construction equipment at some sites would cause nitrogen dioxide concentrations that exceed National Ambient Air Standards under certain meteorological

conditions. This would be a short-term effect, but would last for as much as 100 to 140 days in such sensitive areas as the crossings to be constructed on the Mississippi, Ohio, and Monongahela Rivers.

It is assumed that gas purification columns to be located in the Prudhoe Bay area where gas is prepared for delivery to the pipeline would be operated in a closed loop, and that no air pollutants will result from them.

Dust from construction activities would also create short-term adverse impacts on air quality and visibility. This problem would be severest in the arid soils of the western States where as much as 6 tons of dust per mile of ditch could be suspended in the air by construction activities.

3.OV.15 Environmental Noise

Ambient noise levels along much of the proposed 6,000-mile pipeline system are now very low and any pipe hauling, pipeline construction, or operating noises will be noticeable. Federal regulations are inadequate to reduce the noise from diesel trucks hauling pipe to construction sites.

Where the pipeline passes near towns and farms, construction equipment noise will be loud enough to be highly annoying to thousands of people, and hundreds are expected to complain to authorities. The noise will be of relatively short duration.

There are at present no Federal regulations specifying permissible noise levels for stationary gas turbines. The National Electrical Manufacturers Association (NEMA) guidelines were declared obsolete and new industrial noise regulations are being prepared by the American National Standards Institute. However, there are in existence other noise regulations which must be complied with. Such regulations are, for instance, Occupational Safety and Health Act (OSHA) guidelines for work crews, and the regulations of U.S. Department of Housing and Urban

Development for outdoor noise in residential areas. There are also State and local noise regulations.

The Northern Border report presented the noise ranges of various types of construction equipment. Sound levels may range from 68 to 95 db(A) when measured at 50 feet, except for occasional use of impact equipment which ranges up to 105 db(A).

Compressor station operating noises will be long-term and those located in Oregon are likely to violate the Oregon Noise Control Law. Compressors will be audible for 6,000 to 7,000 feet and the degree to which their noise annoys people will depend on their location with respect to human habitation. Periodic venting of high pressure gas from the pipeline and compressor stations would cause temporary but severe increases in sound level. These maintenance check or emergency blowdowns would occur about once a year and last for 45 minutes on the pipeline and 5 minutes at a compressor. They would be audible for 15 miles.

The operational noise from compressor stations with built-in silencers will be 66 to 71 db(A) at the compressor station boundary, and will range between 56 to 61 db(A) at approximately 800 feet from the boundary. It was estimated, for instance, that for the Los Angeles pipeline the noise

level at residences nearest to the compressor stations was less than 45 db(A), which is well within the limits allowed for outdoor noise in residential areas.

The addition of compressor units to the existing compressor stations for the San Francisco pipeline will increase the noise level. One additional unit of equal power would increase the noise level by 3 db(A) at the same location. However, even with the addition of compressor units the mean noise level at nearby residences would be 51 db(A) or lower.

The noise level from the gas blowdown is high and was estimated at a maximum of 140 db(A) at a distance of 100 feet from the stack. However, this noise occurs seldom and with a stack silencer it could be brought down to 80 db(A).

Operating noises would have greater impacts on wildlife behavior than on human health over the northern portions of the pipeline system. The additional noise from the gas collection and processing facilities at Prudhoe Bay will be incremental to other operations related to oil production.

3.OV.16 Health and Safety

There are fire and health hazards involved in the gas processing operation which will occur at Prudhoe Bay. Natural gas is easily flammable, becomes explosive when confined, and when purified is odorless and can act as an asphyxiant. The propane used as a refrigerant is also flammable and, being denser than air, poses an even greater threat of fire than natural gas. The threat to human health and safety is increased because Prudhoe Bay is a relatively populated area due to the combined oil and gas-field operation; because natural gas unless odorized will not be noticed in case of leakage; and because the multitude of pipes and valves increases the likelihood of occasional natural gas or propane leakage. It is assumed that gas leakage detectors, flame detectors, alarm signals, etc., fully automated with redundancy features for higher reliability will be provided by the Applicant to reduce the fire or explosion hazard.

3.OV.17 Pipeline System Repairs

Damage by outside forces, a construction defect, or a material failure could all cause a failure in the pipeline system resulting in a loss of gas and requiring emergency repair. In 1971 there were 410 reported failures of gas transmission lines in the U.S. which caused $2 million in damages, 3 deaths, and 24 injuries.

Repair activities at some locations, and in some seasons, may cause damage to the environment more severe than that resulting from the initial construction. This is particularly true in the areas of continuous permafrost in Alaska and Canada, but because of the large investment involved and the large number of people dependent upon delivery of the gas, it is not reasonable to assume that major repairs will be postponed until ideal conditions prevail.

Emergency repairs in the Arctic would involve the movement of heavy equipment across the tundra without regard to the condition of the soil and without benefit of snow/ice roads. In winter this will result in the destruction of plants and the insulating organic mat protecting the soil, with thaw consolidation and erosion a probable result. Summer repairs would cause catastrophic damage to arctic

vegetation and soils, and would cause severe disturbance of migrating caribou and waterfowl.

Repair activities on the southern routes would also result in a range of adverse impacts depending on the location and local environmental conditions.

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4.OV Mitigating Measures in the Proposed Action

4.OV.1 Introduction

The Applicant is not definitive enough in many areas to assure that proposed mitigation will minimize the impact on the environment. Basic deficiencies associated with final alignment, pipeline system design and construction procedures are highlighted below.

A. Final Alignment

Minor alignment changes, not to be confused with alternative routes, are changes in the proposed alignment to circumvent unstable areas, recreation areas, potholes and wetlands, wooded areas, rivers and stream crossings in order to avoid interference with fish spawning areas, and to minimize the number of river, highway, and railroad crossings. Applicants have proposed judicious route selection as a positive mitigation measure but this has not yet been accomplished. As stated by the Applicants, mitigation will be accomplished during the final design phase through final route selection to avoid the conditions indicated above.

B. Pipeline System Design

The proposed pipeline system passes through the Arctic, subarctic, and temperate zones in the United States and Canada. It crosses many geographic features including major river crossings, seismic zones of varying magnitude measuring from 2 to 8.3 on the Richter scale, continuous permafrost, discontinuous permafrost, steep slopes, and floodplains.

Design normally is done in phases that can be defined as conceptual design, preliminary design and final design. The applications submitted for analysis were considered to be in the conceptual design phase.

The Applicants have basically addressed environmental concerns, environmental effects and mitigating measures related to a pipeline system. All of the problems of construction and operation created by the geologic occurrences are within the realm of engineering feasibility. The major part of the system does not go beyond the current state of the art in engineering, except in the Arctic and subarctic reaches through Alaska and Canada where the proposed burial of a chilled pipeline has never been done. The chilled pipeline concept, while achieving the purpose of maintaining permafrost conditions, develops an ice bulb

around the pipeline and creates problems such as frost heave and interference with stream flow, thereby disturbing the river regime and interfering with surface and subsurface water flow. Design criteria for the arctic and subarctic conditions are not considered adequate; therefore further efforts are needed to prevent pipeline failure in order to mitigate adverse environmental impacts.

Some of the design concepts not considered to be adequately addressed in the Applicants' submittals are listed below. These are not to be considered all inclusive.

Discussion on these items is contained in appropriate sections of this document.

1) Pipe safety factor - Pipe is designed only for hoop stress to meet the minimum required safety factor and ignores external loading. Applicants should show by analysis that their design is satisfactory based on worst case external loading conditions with the pipe in both the pressurized and unpressurized states.

2) Fracture toughness of the selected steel at low operation temperatures should be investigated and controlled by specification.

3) Summer repair and maintenance in the Arctic and subarctic is a major problem in that surface disturbance

upsets the thermal regime. This causes thermal erosion followed by surface erosion which adversely impacts the environment and can threaten pipeline integrity. Once erosion is started it is difficult to stop.

4) Effects of frost heave need further analysis to assure pipeline integrity.

5) The effects of mass wasting remain a major design problem and some allowance for mass wasting should be included in external design loads.

6) Protection of pipe from damage at river crossings caused by river scour and annular ice bulb needs further evaluation.

7) Leak detection methods and procedures need to be addressed.

8) Effects of leaking gas on the environment which could cause explosions, fire, and death to humans, animals, and birds need to be evaluated.

9) Subsurface soil exploration is not sufficient to provide adequate information for system design, final alignment or erosion control measures.

10) Emergency and contingency plans are incomplete.

11) Procedures for seismic monitoring should be considered in areas of high seismic activity.

12) Schedules proposed, especially for the Arctic, are highly idealistic. Planning should be carefully conducted including a contingency plan to assure completion schedules.

13) Gas chill temperature needs to be controlled so that minimum pipeline temperature is compatible with the fracture toughness of the steel.

14) Consideration of remote control valves with automatic shutdown features should be given to the entire pipeline system to assure quick shutdown in case of emergency.

15) Cathodic protection system should be designed in detail.

16) A detailed specification of the properties of the natural gas to be transported is required to assure impurities are removed to eliminate internal corrosive damage to pipe and compressors, and to assure the pipeline is designed for worst case conditions.

17) Operating plans and operations and safety manuals should be submitted for approval.

18) Gas pressure and temperatures for extremes of operating conditions are necessary for the system design.

C. Construction Procedures

The Applicants plan to use conventional equipment and construction procedures to build the pipeline system in the temperate zone. Construction procedures have been modified to accommodate Arctic and subarctic conditions by scheduling construction activities during the wintertime from snow/ice roads. Equipment and materials will be moved to stockpile areas during the summer months by rail, barge, highway and aircraft, then delivered to the jobsite during winter. Approximately 2,000 miles of this pipeline system occur in the Arctic and subarctic zones.

Conventional construction procedures in the temperate zone such as survey, grading, stringing, bending, ditching, welding, coating and wrapping, lowering in and backfilling (see 1.OV.6 above) are well established and known, and generally are in areas where a road network can be utilized to transport equipment and material on a year around schedule. Arctic and sub-arctic areas where roads do not exist create special logistic problems which the Applicant proposes to accommodate with the proposed snow/ice roads. The snow/ice roads have to be constructed each winter and are usable from 3 to 5 months dependent on climatic

conditions and maintenance. Ditching in frozen areas requires special techniques.

Temperate zone construction procedures and schedules can be mitigated to protect the environment through standard procedures, such as rescheduling work to mitigate interference with animals or birds. Applicants have proposed to do this as necessary.

Arctic and subarctic construction must be completed as scheduled in order to use the proposed snow/ice roads for access. Consequently, mitigation measures proposed to preclude interference with the environment will minimize impacts, but these impacts cannot be avoided; therefore, mitigation is not effective. All environmental mitigation measures will be secondary to construction schedules.

4.OV.2 Mitigating Measures Proposed by Applicant

Introduction

The Applicant has indicated that he will execute certain mitigating geotechnical and environmental control measures which the Department assumes will be implemented and the effects controlled to the degree that the Applicant states. The Applicant has also indicated other control measures which (for reasons of engineering, experience with arctic conditions, historic experience with biological response or other expert knowledge held by the Department) are assumed by the Department not to be effective in controlling the adverse impacts to the same degree assumed by the Applicant. Additional mitigating geotechnical or environmental control measures as suggested by the Department, if applied to the project actions, would significantly reduce adverse environmental effects to be expected from the proposal. The latter group of measures are only suggested in the following discussion for future planning consideration and are <u>not</u> assumed active in the environmental impact analysis.

This section categorizes the proposed mitigation measures proposed by the Applicant to protect the environment throughout the proposed pipeline system. The mitigating measures stated below are summarized from the

enclosed draft statement. Specific information for each proposed mitigation measure is not repeated.

A. Measures Assumed Effective

The Applicant indicates he will execute the following mitigating and environmental control actions and the analysis of environmental impact in this statement is based upon the assumption they will be so implemented and the effects controlled as he states and to that degree.

1) Geology

Geologic phenomena which must be accommodated by the proposal pipeline system in order to mitigate adverse impacts on the environment are highlighted below.

a) Geotechnical Considerations

Permafrost in the Arctic and subarctic areas of Alaska and Canada must be preserved to prevent adverse impacts on the terrain. Activities which disturb the delicate heat balance would result in unacceptable erosion and affect the integrity of the pipeline system.

The Applicant proposes to maintain the frozen conditions by operating a chilled pipeline colder than 32° Fahrenheit in permafrost areas and working off of snow and ice roads in the wintertime only when the ground is frozen. The proposal states that the frozen condition of permafrost will be maintained, but describes surface conditions, water flow characteristics, frost heave, and pipe metallurgical properties that necessitate mitigation.

b) Seismic Conditions

Seismic conditions have been mitigated by the Applicants, who have stated that designs would accommodate earthquakes of known and expected greatest magnitude readings determined by the Richter scale. There are areas along the route such as the Owens Valley, where detailed studies of soil conditions in relation to seismic activity have not been done and the Applicants have deferred the study work until approval of the project. For purposes of this statement it is assumed that the Applicants will conform to Federal, State and local laws and regulations, and that impacts from seismic activity will be mitigated.

2) Soils

The Applicant states that the successful construction and operation of the proposed pipeline system requires that the terrain, which includes the soils, be protected from erosion and slope instability. A scheduled program of surveillance of the right-of-way and ancillary structures will be implemented. The main purpose of this surveillance is early detection of signs of erosion, slope instability, or any other potential threat to the system or the environment. At any locations where there is significant erosion or potential instability, remedial measures outlined by Applicants will be carried out as part of a planned maintenance program.

On the right-of-way in the Arctic regions, excavation of the ditch will destroy surface soils. A compacted-snow working surface and a winter road will be required on the right-of-way, and access roads will also be necessary. To mitigate impact on the terrain, no winter construction will be commenced until the ground surface is completely frozen.

Mitigation methods that have been proposed by the Applicant to stabilize soils and control erosion are revegetation, insulation to arrest the degradation of

permafrost (where applicable), and riprap, diversion dikes and drainage ditches to protect erodable surfaces.

The methods of stabilization itemized below illustrate the mitigation measures proposed to stabilize slopes.

- reduce or control loads which could cause slope failure
- increase internal soil resistance through reduction of pore water pressure
- increase resisting forces by earth buttresses or toe loading
- increase resisting forces by structural methods
- special methods, such as freezing or grouting

The Applicants propose acceptable cleanup techniques that will be used to mitigate local harmful effects created by fuel spills.

3) Water Quality

Degradation of water quality is prohibited by State, Federal and local laws. The Applicants propose to comply with these laws, mitigating degradation of water quality by constructing sewage disposal systems at remote

sites that provide secondary treatment of effluent and discharge the effluent from holding ponds onto the surface; by construction erosion control measures across and down the right-of-way; by training personnel to prevent fuel spills; and by planned and scheduled surveillance measures.

4) Vegetation

The Applicant indicates that his revegetation program is planned to mitigate disturbed land surfaces, to prevent soil erosion, to provide wildlife habitat where it has been destroyed throughout the pipeline system, and to reduce permafrost degradation in northern Canada and Alaska. He further states that restoration will require mechanical stabilization methods in addition to revegetation.

Depending on the particular region or site, he plans to use grasses, shrubs, and trees. All species used will be adapted to the region. Seeding mixtures including native species and/or exotics will be used, as deemed appropriate by the administering agency having jurisdiction.

In woodlands, the right-of-way will be revegetated with a grass cover. Provisions for screen plantings to mitigate long-tunnel views will be used.

Marketable timber will be salvaged to mitigate loss of timber.

A land reclamation plan will be prepared to mitigate problems such as alkalinity, acidity, erosion, and leaching by mulching, revegetation and protection from grazing.

To mitigate occurrence of noxious, unwanted weeds, the Applicant is planning to use a limited amount of herbicide such as 2,4D or 2,4,5T.

To mitigate loss of soil nutrients due to construction activities, the Applicant will fertilize. The types and quantities of fertilizer applications will depend on local conditions, deficiencies of the soils, and the problems encountered in revegetation.

Where revegetation fails or has poor success, the Applicant proposes to mitigate by reapplying fertilizer and seeds.

The Applicant plans to mitigate vegetation damage from fuel spills by cleaning up the leaks by hand and restoring the vegetation and soil.

5) Wildlife

a) Mammals

The Applicant has done intensive work along the proposed right-of-way to determine the microtine population and its relation to habitat. Surveys in both summer and winter seasons have determined the population of furbearers and large mammals and their relationship to habitat. These observations developed a base line inventory of this resource; observations will be continued during and after construction to measure any changes, and the Applicants propose to develop and apply mitigation procedures accordingly.

The Applicant proposes to mitigate the primary adverse effects of this project on mammalian species by limiting disturbance to the animals and destruction of critical habitat by project activities. Pollution and increased use of the animal resource will be mitigated by scheduling construction to avoid the most sensitive period of the animal's life cycle, by route selection to avoid critical habitat areas, by a revegetation program, by installation of erosion control devices, by cleanup procedures, by construction of barriers and protective

fencing, and by making project facilities off-limits to non-project personnel.

b) Birds

To mitigate the impact on birds in general, the Applicant states that he has identified critical areas and times of year where waterfowl concentrate in order to avoid disturbance by controlling the flight line and altitude of his aircraft; that work crews will not be permitted to use company vehicles to visit critical habitat areas; that barge traffic will be kept away from bird nesting and molting areas; and that construction will be scheduled to avoid peak nesting periods in areas designated as major wildlife habitats.

c) Fish

The Applicant proposes to mitigate adverse effects on fish by preventing degradation of water quality; by locating and not interfering with fish spawning areas; by withdrawing water for construction where there are no fish; by scheduling construction so as not to interfere with fish migration; by providing buffer zones between the right-of-way and rivers and streams; by preventing blockage of streams during construction; and by employing competent aquatic biologists who will monitor construction, operation,

and maintenance procedures from the standpoint of protecting fisheries.

6) Land Use

To mitigate impacts on land use the Applicant states that special requests and preferences of landowners along the alignment will be given full consideration during all phases of pipeline activities. Following the initial pipeline construction period, all temporary rights-of-way will revert to the original ownership and the land will be allowed to return to its original use where compatible with operation of a buried pipeline.

Construction of fences and gates (with locks) on private roads leading to the right-of-way "to prevent unauthorized access to the restored right-of-way" is proposed as a mitigating measure to deter unauthorized land use.

7) Historical, Archaeological and Unique Area Values

a) Historical Values

The Applicant's submittal contains very few references to applying mitigating measures for historic resources along the proposed route. The mitigation measure proposed is avoidance.

b) Archaeological Values

The Applicants propose to mitigate impacts on the archaeologic resources along the route by the employment of competent archaeologists to further study, inventory, and report upon such values; by monitoring the actual construction and performing excavation of important sites prior to construction; and by training employees to identify materials of archaeological value.

c) Unique Areas

The Applicant has identified few of the special areas, such as proposed ecological reserves, potential scientific study areas and sites suitable for national landmarks. The mitigation measure proposed is to bypass the areas by minor route changes.

8) Recreational and Aesthetic Resources

The Applicant has considered aesthetic values and has proposed mitigation measures to lessen the visual and recreation impact of the pipeline and related facilities by providing detours around construction areas for recreation vehicles. Through areas of steppe and shrub steppe vegetation, all cleared areas other than those within the compressor station compounds will be revegetated with grasses. Through forested areas where viewer sensitivity may be high, techniques to screen fore and middle-ground views of the right-of-way at road crossings will be used as determined by on-site conditions and the requests of regulatory agencies. Techniques include preservation of existing vegetative screens by extending the length of road borings, reducing the right-of-way width at road crossings, and reestablishing disturbed screens by planting. All such mitigation measures will be implemented at the direction and with the guidance of appropriate government agencies.

9) Air Quality

The Applicant has proposed to prevent degradation of the existing air quality along the route by utilizing air

pollution control devices on construction vehicles and by complying with applicable Federal, State and local minimum standards on stationary sources. Dust created by construction will be mitigated by control measures such as spraying water.

10) Noise

The Applicant will mitigate noise pollution by complying with applicable Federal, State and local regulations. He will monitor noise during the construction procedure to identify mechanical machinery that produces noise not in compliance with applicable regulations and take corrective measures. He further states that corrective measures to minimize noise, such as replacement of mufflers, will be standard procedure.

The Applicant proposes to mitigate the noise from compressor stations by selection of locations which have the least impact on near-by residents as well as by complying with Federal, State and local laws.

11) Pipeline Repairs

The Applicant plans to mitigate impacts created by pipeline repairs by preparing a mainline break plan as part of his operation manual. It will preplan methods of repair, locations of personnel and equipment needed for repair, and estimated time of repair.

B. Measures Assumed Not Effective

The following environmental control actions indicated by the Applicant are, for reasons of engineering, experience with arctic conditions, historic experience with biological response or other expert knowledge held by the Department, not assumed effective in controlling the adverse effects associated with the activity to the same degree assumed by the Applicant. Therefore, the analysis of environmental impact contained in this volume is made without the assumed degree of control.

1) Geology

Mass wasting consisting of solifluction, liquefaction, deep creep in the Arctic and subarctic and

landslides, slumping, and subsidence throughout the pipeline system have been addressed by the Applicants. Any of those phenomena can generate external loads of concern to pipe integrity, or to the environment if the construction activity triggered the mass wasting. Mitigation measures proposed by the Applicants have generally been deferred until final design, so specific site mitigation measures cannot be termed acceptable at this time.

2) Soils

In general, the Applicants have discussed effective mitigating measures except for Arctic areas. For oil spills, the Applicant proposes to add nutrients to the affected soils. Because the cold temperatures and short summer season do not lend themselves to bacteria growth, this mitigation measure is considered ineffective. To help maintain the thermal balance along the pipeline route, the Applicant proposes to strip the tundra mat and replace the mat over the ditch backfill. This is only proposed for areas where the mat is sufficiently thick. Because this does not satisfy conditions along the entire Arctic route

and because it is not clear how this will be accomplished in frozen soils, this method is considered ineffective.

3) Vegetation

Revegetation is in most cases an acceptable erosion control method with the exception of northern Canada and Alaska. These areas have a very short growing season and there is not sufficient evidence that vegetation can be re-established in the short time available. Degradation of these soils due to thermal imbalance along the pipeline trench in the first summer after installation further aggravates this problem.

4) Wildlife

The Applicant has proposed a number of measures that if successful will reduce project impact on fishery resources. Not discussed adequately in contingency plans to mitigate impacts on aquatic life are: disposal of methanol and other pollutants, surface drainage controls, and changes in stream flow caused by the formation of the ice bulb around the pipe. The ice bulb could change stream channels

and flow characteristics enough to damage fishery resources; if the ice bulb causes aufeis formation, the resultant change of flow and temperature regimes of streams could adversely affect oxygen levels in the streams during winter, as could disposal of sewage and other organic materials. Also not discussed are effects of water withdrawals for ice roads, construction camps, and compressor stations which could reduce water availability for fish life.

Many other effects on wildlife were not discussed.

5) Noise

While the Applicant indicates measures to protect construction workers on the job, he fails to adequately discuss other long-lasting impacts during his operation phase such as maintenance and emergency repairs.

6) Repairs

There will be some impacts which can be mitigated mostly by major preplanning. It is not reasonable to assume that major repairs will be postponed until ideal climate conditions exist because large numbers of people will depend on a continuous gas delivery.

In Canada and Alaska where permafrost is present and may thaw when disturbed, emergency repair creates several unique problems. Initial construction is planned to be conducted from snow/ice roads prepared in advance. Emergency repairs, when the pipeline is in operation, will be made without benefit of roads during all seasons of the year. Without a road, even winter repairs can compact the tundra, eventually causing thawing which will result in damage to the environment more severe than that resulting from initial construction. Pipeline repair in the spring, summer, and fall would result in a substantially disturbing impact to the delicate permafrost balance with resulting impacts on soil, water quality and various wildlife. The Applicant proposes to partly mitigate these losses by detailed preplanning and surface restoration procedures.

4.OV.3 Additional Mitigating Measures

The following mitigating or environmental control actions comprise measures which are not planned by the Applicant but which, if applied to the project action, would significantly reduce adverse environmental effects to be expected from the proposal. They are therefore only suggested here for the following subjects.

A. Geology

Mass wasting can be mitigated by the Applicant by defining the exact nature of the local and site-specific geological conditions, assessing the mass wasting hazards in terms of pipe stresses, and developing design solutions for critical areas prior to construction.

B. Soils

Complete procedures for cleanup of oil spills should be prepared by the Applicant.

The Applicant should also establish criteria for backfill in the Arctic area so that the thermal balance will be maintained without reliance on replacing the thermal mat.

The Applicant should identify the quantity of backfill material required and methods used to supply this material along the pipeline route.

Research needs to be continued in this northern area where permafrost and arctic weather make severe growing conditions and reseeding success limited.

C. Vegetation

Of major concern to any revegetation program is the seedbed, or soil left at the surface. In areas where a sufficient soil profile exists and it is salvaged and replaced, there should be less difficulty in reseeding. In those areas where there is little soil and/or the soil is mixed with the subsurface material, revegetation will be very difficult, even with heavy applications of fertilizer.

Cropping of the seed by small rodents and of the new plants later by livestock or big game will be a major problem in the reestablishment of vegetation. Animals are frequently attracted to exotic plants and are especially attracted to fertilized plants of any kind. Continuous short cropping of any plant usually prohibits its establishment or eventually kills it.

Degradation of ice-rich soils must be retarded during the early phase of pipeline operation by appropriate insulating materials to restore the thermal balance along the pipeline route.

D. Wildlife

There are several additional measures which could be undertaken by the Applicant to further reduce impact, but not all impacts can be fully mitigated. Some of the additional measures are:

During spring of the construction period in Alaska and northern Canada, the Applicant should monitor caribou movements to insure that activities do not interfere with migration of caribou.

The Applicant should not operate mobile ground equipment off the right-of-way, access roads, State highways, or authorized areas, in order to minimize disturbance to wildlife.

The Applicant should provide blasting schedules that prevent disturbances of caribou, moose and musk oxen.

The Applicant should conduct sufficient research to determine a safe (nondisturbing) aircraft altitude while over large mammals.

The Applicant should conduct a monitoring program sufficiently long and detailed to determine effects of the total project (line and compressor stations) on mammals. Program objectives should be to determine adverse impacts and to readjust operating procedures to mitigate impacts.

Applicant should conduct a research program long and detailed enough to identify marine mammal populations, their locations, time in the shipping area and their food supply.

Applicant should have on hand sufficient pollutant cleanup devices and should train shipping crews and station cleanup specialists at the wharf areas before shipping starts.

The lack of detailed information on the exact location of the proposed route, of access roads, spoil areas, borrow areas, storage and preparation sites, etc., makes the formulation of specific measures to mitigate fish and wildlife and other environmental losses very difficult. Mitigation might best be achieved by the establishment of technical review teams and construction monitoring teams for various stretches of the pipeline. Such teams should be

financed by the Applicant. These teams could include State and Federal fish and wildlife biologists, archaeologists, soil scientists and other resource personnel familiar with local conditions and values.

These on-the-ground specific mitigation decisions cannot be made on the basis of a very general survey of the possible path of the proposed route and without any indication of the off-route locations, such as borrow areas, to be impacted. There are some general mitigation procedures adaptable to various types of situations which will be encountered during construction.

Minor route diversions may be necessary to avoid wetland areas, big game wintering areas, nesting and denning trees, productive aquatic habitat areas and other critical areas of natural habitat. Elk, moose, and deer winter ranges and elk calving areas should be avoided during critical periods. Critical periods for such animals include the winter range areas during December to March.

Sage grouse strutting areas that are found along the route in eastern Oregon and Nevada should not be disturbed from mid-March to mid-May. Again, work scheduling may make this difficult.

Additional measures which the Applicant could take to reduce major impacts on birds are as follows:

Because of the national and international implications if waterfowl losses are caused by the presence, operation and maintenance of the proposed pipeline, it is suggested that detailed studies of disturbance factors causing population losses must be made.

Continuing flights for maintenance and surveillance purposes over and to the proposed pipeline and related facilities will constitute a continued disturbance factor on geese and fresh water ducks. Studies should be conducted to determine lateral distance disturbance thresholds, possible accommodation to disturbance, possible cumulative and long-term effects of disturbance, and reactions to other types of craft by geese (particularly snow geese) and fresh water ducks. Schedules should be adjusted to reduce impacts. Conducting this research may also adversely affect the snow geese population unless carefully devised and carried out, probably without aircraft or other vehicle support.

The preferable mitigation procedure on potholes and other wetland areas is to make minor route changes to avoid these very valuable and rapidly vanishing wildlife areas. In detailed route planning these areas should be avoided.

The recommended technical review teams should participate in the selection of the exact alignment of the route, in the choice of access routes, spoil areas, borrow areas, etc., and in the selection of land reclamation or resource replacement alternatives. Since construction impacts can be magnified or decreased, depending on the attitude of the contractor and his employees, monitoring teams should work closely with the contractors during construction. Careless action by a single heavy equipment operator in fragile ecosystems could negate the most careful planning and the best intentions of the Applicant.

Detailed route selection through the cooperative efforts of the Applicant and the technical review teams can minimize adverse environmental effects. They can look in detail at the minor route diversions necessary to avoid potholes, wetland areas, bottomland hardwood concentrations, woodlots, nesting and denning trees, especially productive aquatic habitat areas and other critical areas of natural habitat.

Microwave towers along the proposed route will be 200-300 feet high. Towers with white strobe lights tend to attract birds during migration. Red warning lights would be less attractive to birds. Towers should be as low as possible.

There are some special situations where specific mitigation measures are indicated.

In Montana, oxbow islands above Frenchman Reservoir used by nesting geese are crossed by the route. Construction should be done in such a manner that predator access to these islands is not provided. The oxbows should be cleared of spoil materials.

If the proposed technical review teams locate Prairie and peregrine falcon nests in close vicinity to the route, construction activities should not be carried out in the area from mid-February through July.

Based on technical review team survey, sage grouse strutting ground areas found along the route in the Lime Creek, Montana drainage should not be disturbed from mid-March to mid-May.

A survey of the buttes from Mile 83 to Mile 85 in Montana is needed to determine their use by breeding birds of prey. If substantial use is found, the pipeline should be realigned to pass south of this area by two miles.

The effect of barge and lighter traffic on waterfowl using the areas through which shipping travels and is unloaded must be studied to assure that during the molting period waterfowl will not be disturbed.

An adjustment of shipping periods cannot be made because of the short time during which the coast area is free from ice and used by both the molting birds and shipping. Molting areas and times must be delineated so that shipping lanes and wharf areas can be best located and shipments properly scheduled or restricted.

The proposed route could be relocated in some areas to reduce impact on waterfowl. Several of these areas where minor relocations may be feasible involve existing wildlife management areas in Montana, Illinois, Ohio, Idaho, Oregon, Nevada and California.

Some additional measures the Applicant can take to further reduce the impact on fish are as follows:

Additional studies should be made on the effect of methanol test fluids on arctic char and grayling because of the proposal by the Applicant to dispose of the spent fluid on the land.

One very significant facet has not yet been tested. This is the effect of ambient methanol on fertilization success of fish species. Sperm, and to a lesser extent the unfertilized egg, could be extremely sensitive to small doses of methanol in the environment. It is also possible that doses of methanol would interfere with the chemosensory

mechanisms integrally involved in the spawning process. No information is available and this factor together with the demonstrated lethality of 1.0% methanol on the fertilized eggs would suggest that these studies be carried out by the Applicant.

After construction of the proposed pipeline and its related facilities in Alaska and during its operating period, a number of programs must be set up to monitor the effects of the presence, operation and maintenance of the gas transmission system on natural systems and animals. Some of the programs should start before construction. Monitoring programs should include, but not be limited to, the following:

1) A monitoring program should start as soon as the Applicant's permit request is approved to gather information to be used to judge the effect of operating a cold pipeline and releasing treated sewage effluent on fish habitats.

2) Areas of aufeis should be mapped in enough detail so location, thickness and extent of aufeis is known along the proposed route, for a distance of one mile up and downstream from the centerline of the pipe, and during all seasons.

3) Temperature records should also be kept in all streams that support a fish population downstream from proposed sewage treatment outfalls.

4) Pre-construction temperatures should be taken along the pipe centerline. Post-construction temperatures should be taken immediately downstream, 100 yards downstream, and 1/2 mile downstream of the pipeline.

This information is necessary to determine if the operation of a cold pipeline and release of treated sewage effluent will change the temperature regime of a stream sufficiently to affect fish populations.

Additional studies need to be made for spawning and overwintering areas in those streams and estuarine areas not already surveyed.

Blasting restrictions (usually 1/4 mile from fish spawning areas) need to be promulgated and used.

A study should be undertaken to establish the significance of impacts from a pipeline break or leak in aquatic habitats. Results would enable analysts to predict consequences of such events. The study should include tests on aquatic wildlife at a variety of distances from a pipeline break or leak. It should include tests of long-

term and short-term exposure of aquatic animals and habitat to pipeline break pollutants.

Uninterrupted movement and safe passage of fish should be assured. Any artificial structure or any stream channel change that would cause a barrier to fish should provide for a fish passage structure or facility that meets all Federal and State requirements.

Pump intakes should be screened to prevent harm to fish.

Abandoned water diversion structures should be plugged and stabilized to prevent trapping or stranding of fish.

If material sites are approved adjacent to or in certain lakes, rivers, or streams, it will be necessary to construct levees, berms, or other suitable means to protect fish, fish passage, and water quality.

Culverts should be installed to provide for fish passage.

Channel changes should be avoided in fish spawning areas.

Fish spawning areas should be protected from sediment where soil material is expected to be suspended in water as a result of construction activities. Settling basins should be constructed to intercept silt before it reaches streams

or lakes, whether or not fish spawning areas would be directly affected by the sediment.

The crossings of watercourses, sloughs, and wet areas should be avoided during fish spawning periods or at other times critical to their life cycles.

E. Land Use

In certain cases the Applicant should be required to widen, and where necessary surface and maintain, all existing road used in pipeline construction and operation. The Applicant should be required to construct new roads over Federal lands, to the specifications of the agencies involved.

Measures are required to discourage the general public from gaining access to the "restored right-of-way" from public roads. Unless the right-of-way itself is fenced, gated, barricaded or otherwise restricted at public road crossings in conjunction with the proposed pipeline, the public will have relatively uninhibited access.

F. Historical Values

A competent historian meeting approval of the National Park Service should be employed to make an evaluation of the entire route to identify the items and sites of historical significance and to monitor the project development to assure proper measures are undertaken to avoid loss of significant values and to insure compliance with procedures under Public Law 93-201, Section 106 of the Historic Preservation Act of 1966, Executive Order 11593 and Title 36, Code of Federal Regulations (Part 800). The Historian could also assist in coordination with the proper State Historic Preservation Officer and with all other Federal, State and local historian groups.

G. Archaeological Values

Upon discovery of an archaeological find, the professional archaeologist would be notified so he may make an evaluation. Every effort will be made to prevent destruction of any archaeological find.

The Applicants' proposals need to be bolstered to adequately meet legal requirements and professional standards. Procedures developed by the Advisory Council on

Historic Preservation and the Secretary of the Interior for implementing the Historic Preservation Act of 1966, Executive Order 11593 and the Reservoir Salvage Act, as amended by the Historical, Archaeological, and Scientific Preservation Act of 1970 (Public Law 93-291) must be followed.

Archaeological survey work must be done at the same time the pipeline is staked so that on-the-ground decisions to avoid or salvage the archaeological resources can be made.

An archaeologist should monitor the pipeline trench to minimize the damage to hidden and unpredictable archaeological and historical finds. To provide for the highest and best use of the archaeological and historical resources in such cases, archaeological resources must be salvaged in lieu of destruction by professionally approved research design methods. Surveillance of the archaeological resource stipulations must be coordinated with Federal, State and local agencies having an interest in the land and/or the resources. Their needs and desires should be considered in making decisions so that the best use of the resource can be made in the most economical manner. Consideration must be given to the data and materials recovered as a result of the proposed action. Funds for

laboratory work, research, curatorial work, storage and publication of results must be provided to complete the job of mitigation and to comply with legal intent.

H. Unique Areas

These areas have unique biological or physiographic features that make them worthy of preservation for scientific study and use as undisturbed control areas for experimental work.

In northern Alaska and Canada there are several such sites and others may be identified in other places. The proposal if implemented could have severe impacts upon the integrity of such sites. Mitigation would be to make minor route changes to avoid the sites entirely or else to decrease the total impact by limiting development to the margins of the site, thus preserving the major portion. Several suggested route changes have been identified in the various systems to accomplish the purpose of protecting these unique values. In northern Alaska the Jago River, Shublik Spring and Sadlerochit Spring would be impacted to a great extent unless measures are taken to avoid use of the waters.

I. Recreation and Aesthetics

In forested areas, the pipeline right-of-way will be cleared of all trees, stumps, and understory vegetation. Shrubs and grasses should be allowed to revegetate cleared areas. Trees and taller woody plants will continually be removed for the life of the project. Height of surrounding trees will, in some cases, provide a "screen" or "buffer" for the cleared right-of-way unless viewers are able to look directly down the cleared area or are observing the landscape from a higher or lower elevation. Since forested areas usually occur in mountainous regions where diversity of topography, vegetation, waterforms, and color often have inherent scenic or aesthetic qualities, adverse visual impacts are often more pronounced because of the total landscape involved. Such areas should be avoided whenever possible. In addition, the "tunnel" effect of the pipeline right-of-way, as it passes through forested areas, cannot be avoided, but the visual impact can be somewhat softened by "scalloping" or feathering the right-of-way edge.

Minor alignment changes can be used as an effective measure to reduce environmental impacts of the proposed pipeline. A detailed analysis of natural resources, land use, and aesthetic and recreational factors along the right-

of-way is required. Also, the absence of certain detailed information on the proposed route, such as access roads, spoil areas, storage areas, and other requirements closely related to relocation, demonstrates the need for additional detailed analysis.

Some of the suggested alignment changes identified are as follows:

Moyie River, Idaho

Umatilla River Crossing, Oregon

Umatilla National Forest, Oregon

Wallowa-Whitman National Forest, Oregon

Brogan Canyon, Oregon

Little Valley Canyon, Oregon

Cedar Mountain, Oregon

Red Butte Area, Oregon

Bull Creek Canyon, Oregon

North Central Nevada

Inyo National Forest, California

Tule Calving Area, California

Red Mountain to Victorville, California

Dixie Valley, Nevada

Southern California Desert Route

West Fork River, Iowa

Big Bend State Conservation Area, Illinois

Starved Rock State Park, Illinois

Mattiessen State Park, Illinois

Mingo Creek Park, Pennsylvania

Round Hill Regional Park, Pennsylvania

Salamonie State Recreation Area, Illinois

North Dakota Badlands

Little Missouri River Crossing

Specific details of the proposed route changes can be found in Chapter 4 of the separate reports.

Where rerouting of pipeline is not practical and where the recreation area has been acquired or developed with the assistance of Land and Water Conservation Fund money, the Applicant must comply with Section 6F of P.L. 88-578 (Land and Water Conservation Fund Act of 1965) regarding the Secretary of the Interior's approval of conversion of use of Federally assisted recreation areas.

Where recreation areas cannot be avoided, restoration of the right-of-way should be done so as to provide the recreational opportunities that were present before construction. This will include rebuilding road systems that have been damaged, replacing facilities and

reestablishing vegetation that screens the open right-of-way through the park.

The Applicant should take necessary steps to avoid closed canopied hardwood forest areas where they occur within designated park and recreation areas and at river crossings where recreation and aesthetic values are significant.

J. Air Quality

There are a number of specific measures that can be implemented in order to mitigate the adverse effects on air quality. The basic sources of air quality degradation are construction-related engine-powered equipment, compressor stations, burning of materials and maintenance operations. Mitigating measures should address visible, particulate, sulfur oxide, carbon oxide, nitrogen oxide, volatile organic, hydrocarbon, photochemical oxidant, and odor emissions. Emissions from the sources noted above are a mixture of several classes of emission; generally one is predominant. In identifying a mitigating measure, it was considered that if the major emission were controlled satisfactorily, lesser but connected emissions would also be

controlled. Some additional mitigating measures are given in more detail below.

Fugitive dust emissions can be largely eliminated if "reasonable precautions" are applied. Several of the States along the proposed route have specified that precautions shall consist of:

Water application

Covering of dusty haulage loads

Paving or other dust-free surfacing of roads

Planting suitable vegetation

Fugitive dust emissions will be most prominent during construction operations. Principal sources of fugitive dust will be excavation operations and traffic on access roads, the right-of-way, and haulage roads. All of these will be aggravated by wind. During excavations and primary earthmoving stages, there are practically no measures that can be employed to reduce the release of dust from ground breaking and transfer of earth. These operations are concentrated in the middle hours of the day, when natural atmospheric dispersion is most intense. This is a disadvantage in the case of dust, because it decreases the visibility due to dust and extends the range of the effect.

After excavated earth has been loaded aboard trucks for hauling, the fugitive dust emissions should be almost completely eliminated by application of water to roadways, and by covering or water application to loads. Heavily used roads and access ways should be treated by application of oil as a longer-term means of suppressing fugitive dust.

When construction and installation of the pipeline is completed, project-caused fugitive dust should be eliminated completely by suitable planting of grass and other vegetation.

Research is necessary to understand the consequences of pipe rupture in the environment. The gas expansion from such high pressure suggests that gas densities may be greater than ambient air, which would then result in a very large air pollution problem at the least and a disastrous fire hazard at worst.

Properly tuned and operated engines emit negligible particulate matter and present a minor problem. The limited impact that does occur can be mitigated by requiring proper vehicle engine maintenance. The gas turbines of the compressor stations will emit no particulates during the operation phase, so no mitigating measures are recommended.

Open burning operations can emit significant amounts of particulate matter. These emissions should be minimized by adopting the following procedures:

1) Employ open burning of land-clearing wastes and construction wastes only when sanitary landfills are not within reasonable hauling distance.

2) Avoid open burning of dangerous materials (e.g., chemicals, solvents, pesticides, explosives), oily and asphaltic materials, and plastic materials.

3) Open burning should be conducted as far from populated areas as possible and in no case closer than 1,000 feet to any inhabited residence.

4) Employ open burning only during daylight hours, and only when atmospheric conditions are conductive to rapid dispersion of pollutants (Class C atmospheric stability or better).

5) Fires for the comfort of personnel should be confined to burners designed and manufactured for this purpose, which employ fuel refined for this purpose.

The principal method of reducing the impact of nitrogen oxide (NO_x) emissions is to maximize their dispersion in the atmosphere. Generally, this is achieved by providing exhaust stacks that are as tall as possible. Dispersion is

necessary because there is no demonstrated, commercially available technology that will significantly reduce NO_x emissions from engines fired by fossil fuels.

In those States which have laws which limit absolute emission rates of NO_x as a function of the energy consumed, new technology must be found if the emissions from both the construction equipment and the gas turbines of compressor stations are to conform. Possible mitigating measures to meet those laws include catalytic converters in the exhaust lines, controlled combustion by water injection or fuel additives, or staged combustion. These measures will mitigate the impact but the absolute standards in those states will still not be met.

Although carbon monoxide emissions are not expected to make any significant contributions to ambient air pollution, their impact should be minimized by measures that insure the closest possible approach to complete combustion. These measures include tuning of vehicle engines, steady operation of compressor engines (operating at the optimum conditions of combustion efficiency), and the use of "good practice" in management of fires employed in trash disposal and comfort of construction personnel.

Hydrocarbon emissions will appear only to the extent that construction and transfer vehicles emit hydrocarbons as a result of inefficient combustion of fuel (diesel or gasoline). Therefore their impact should be reduced by the same techniques employed to reduce carbon monoxide emissions. There is no significant emissions of hydrocarbons from gas turbines, so mitigating measures are not necessary to control this aspect of air quality.

If air quality alerts are given, all mobile equipment should cease operation for the duration of the alert and all fixed installations should carefully monitor their facilities to insure compliance with local law.

K. Noise

The primary noise impact is sound emitted by engine powered heavy vehicles, thus the primary mitigating measure should be a requirement that all diesel engine powered vehicles or equipment be equipped with mufflers. Since the U.S. Environmental Protection Agency has recently adopted noise standards for trucks used in interstate commerce, these standards should be applied to all off-site diesel engine powered trucks.

All on-site engine powered equipment should be equipped with mufflers that are equivalent to high quality mufflers used on diesel trucks. Since there is a wide variety of equipment to be used, it is not possible to specify individual muffler types or to set standards on noise levels to be met. It is not suitable to require mufflers without specific muffler performance requirements, since many pieces of construction equipment have "mufflers" but they are completely ineffective in reducing noise. The use of mufflers will also reduce the noise exposure of equipment operators and nearby construction personnel to meet Occupational Safety and Health Act noise limits.

Air compressors should meet U.S. Environmental Protection Agency standards.

Annoyance from construction noise is greatest during the evening hours. In order to mitigate the disturbance, construction should be avoided between 9 p.m. one day and 6 a.m. the next. Further mitigation would be to cease construction at 6 p.m. in lieu of 9 p.m. but the benefits to be gained are small.

Since blasting results in environmental noise and ground vibration of large magnitude, control of explosives use is important. A valuable means is to write an explosives

management plan which is submitted to the appropriate agency when detailed knowledge of the need for and the potential adverse effects of any blasting is known. This plan should set forth policy and should include blasting techniques; blasting locations; and methods for avoiding rockfalls, landslides, and damage to structures, people and wildlife, particularly aquatic. Minimizing charge size and blasting only during the day should be required.

Noise from the compressor stations will be the only environmental noise problem during the normal operational phase. The operating noise will be continuous and for the most part will intrude on extremely low ambient levels, contributing a permanent and significant degradation of the environment in a circular area surrounding the station. For mitigation of this noise, several factors must be considered: the degradation, the absolute levels, the variability of the sound and the range of audibility.

The compressor stations to be installed will have to meet the State noise regulations. To do this, either engineering noise control must be applied or more property must be procured. Although the Applicant has provided no details of its characteristics, the stations will be like others of their kind, at least acoustically, so it is

reasonable to estimate that the technology exists to control compressor station operating noise. All stations should be designed to meet the night standards of the State in which they are located. The trend in State noise control legislation has been to regulate stationary noise sources, and eventually all stations will have to meet standards similar to those of Illinois. Thus, it would be more cost effective to implement the noise control during the design phase, or at least to make allowance for future installation of muffling equipment. In this way the range of audibility and the noise pollution in States other than Illinois will be substantially reduced.

The noise within a compressor station can exceed the limits of the Occupational Safety and Health Act which is 90 dB(A) for 8 hours. Since the noise will be steady and continuous, the 8 hours provision is relevant. The station can be designed to bring these levels down below statutory limits. There is strong pressure on the Environmental Protection Agency to reduce the limit to 85 dB(A). Thus for any station in which it is expected that an employee will work for 8 or more hours in any day, the station should be designed for a maximum level of 85 dB(A).

All gas vents should be equipped with muffling devices designed specifically for the reduction of supersonic jet noise which would occur when vents are used. This particular noise source is very intense and would be heard for long distances without a proper muffler.

Prior to the initiation of compressor site construction, ambient noise monitoring should be accomplished, and is proposed by the Applicant, to insure that compressor stations have little noise impact on the surrounding area. In particular ambient noise monitoring will be necessary in order to determine the zone of audibility of these stations. Such data will be useful in designing the station noise control features. In addition the predicted zone of audibility will be useful, if given to city or county land use agencies, for applying pressure to avoid future residential development in the near vicinity of these stations, particularly along eastern portions of the route.

Monitoring the noise exposure of construction equipment operators, truck drivers and other employees is necessary to insure compliance with the Occupational Safety and Health Act.

The shock of blasting can be controlled to a significant degree by various technical means. Perhaps the most common

of these is the use of millisecond delays between each of several parts of a single blasting event. By doing this, the maximum velocity of any given particle of rock can be kept to less than 2 feet per second. Such a procedure should be implemented by the Applicant to be within all States' maximum velocity restrictions and to minimize rockfall hazards.

While all of the above measures would reduce the total noise, it is not possible to fully mitigate this impact.

L. Repairs

An additional measure which could lead to reduced impact would be increased research by the Applicant in air-cushion vehicles or other methods to mitigate vegetation and soil disturbance in permafrost areas.

5.OV Adverse Effects Which Cannot Be Avoided Should the Proposal Be Implemented

Introduction

The following discussion of the adverse effects which cannot be avoided should the proposal be implemented assumes that the mitigating measures proposed by the Applicant which the Department believes will be effective will be implemented. The following discussion also assumes that the mitigating measures proposed by the Applicant which the Department assumes cannot be made effective and that additional mitigating measures not proposed by the Applicant but discussed in Chapter 4 of this statement are not or will not be implemented.

5.OV.1 General

A. Final Alignment

The alignment as depicted needs refinement by producing at a larger scale to make site-specific locations available for analysis. Minor reroutes cannot be made to eliminate site-specific adverse environmental impacts utilizing documents as submitted.

B. Pipeline System Design

The conceptual design is inadequate to analyze the geotechnical aspects in a quantitative manner. The information submitted does not satisfy the requirements to conduct complete technical analysis to determine pipeline integrity, nor does it address mode of construction other than burial. The information submitted for analysis does not conclusively show that project reliability or design will minimize impact to the environment.

C. Construction Procedures

A winter construction schedule in the Arctic, as outlined by the Applicant, without all-weather accessibility

is highly idealistic and dependent on many variable uncontrollable conditions, and is not considered feasible. Where roadways exist to permit access on a year-round basis, the schedules are dependent on ideal conditions, but are considered feasible.

5.OV.2 Unavoidable Effects

Mitigating measures proposed by the Applicant not considered adequate are summarized by subject and are:

A. Climate

The schedule is dependent on completion of the Alaska/Canada portion of the pipeline (Mile Post 0-492) in one winter season. Adverse climatic conditions during the winter season that this construction takes place will unavoidably delay the schedule. The pipeline line must be chilled the first thaw season after construction to maintain stable conditions in permafrost areas.

B. Topography/Landscape

The project will affect the topography/landscape by disturbances related to construction activities, and presence of compression stations and other appurtenances. Changes to the topography/landscape will occur and are unavoidable should this proposal be implemented.

C. Geology

The project will be impacted by geological conditions. Without criteria and final design, analysis of geological impacts on the pipeline system cannot be evaluated to assure pipeline integrity (see 5.OV.1.B above).

D. Soils

If the project is implemented, loss of soils will occur through erosion; burial under permanent facilities and waste disposal areas; destruction by stripping along rights-of-way, material sites, and access roads; and compaction. Losses are considered negligible on a regional basis, but could be significant on a local site-specific basis.

E. Water Quality

The Applicant proposes to comply with applicable Federal, State, or local regulations to protect water quality. However, accidental spills of pollutants and erosion control facilities that fail and allow sediments to reach streams or lakes will degrade water quality. The Applicants have indicated that measures will be taken; the

measures are adequate but local site-specific areas will experience degradation of water quality by pollutants.

F. Vegetation

Revegetation is the Applicants' primary procedure for protection of the surface. It is planned that revegetation will prevent erosion, stabilize slopes, and protect the undisturbed organic layer to preclude loss of mammal and bird habitat. Successful revegetation in the Arctic has not been proven sufficient to show adequate control of any or all of the impacts created by this project in the first year after disturbance. Mechanical erosion measures to achieve stabilization must be used the first year to permit the vegetation to establish. In the Arctic and sub-Arctic there will be a loss of native vegetation by construction activities. Temperate zones are more adaptable to revegetation but some productivity losses will be sustained, dependent on time of year of disturbance.

G. Wildlife

The grizzly bear and wolverine populations are two examples of animal species in the Arctic whose numbers will decline along the pipeline route. Decrease of populations will result from some animals choosing to avoid man and the construction activity, some killing of camp marauders, loss from increased hunting pressure, and loss from harassment.

The loss of wildlife habitat for birds and land animals is an incremental loss along some stretches, such as the cornbelt of the Midwest. Wildlife habitat is scarce in a region mostly plowed or otherwise disturbed; therefore further destruction of habitat will cause reduction or relocation of wildlife.

Several unique, sensitive, threatened or endangered species of birds inhabit the vicinity of the present right-of-way. Noise from blasting, flyovers and general construction activity will disturb many of these species so that their total numbers can be expected to decline. Of special concern will be Bald and Golden Eagles, osprey, prairie and peregrine falcons and spotted owls. Nesting sites have been located within a mile of the right-of-way. Various species of geese are especially sensitive to aircraft flyover well about 1,000 feet. Disturbance by

aircraft will cause relocation and loss of some geese. Effects on neighboring wildlife from project-related activities, such as continual noise from compressor stations and the continuing problem of low flying aircraft during the operations phase, are unknown.

Fish and other marine life will suffer loss of numbers should sediments from erosion or pollutants such as fuel or methanol enter their habitat areas.

Many impacts relating to wildlife can only be estimated based on limited experience and study. Studies need to be done to determine acceptable tolerance of wildlife species to prevent relocation or loss of species from planned activities. Such actions can reduce but not eliminate the adverse impacts. Additional monitoring and data gathering to update mitigation efforts will be required to keep wildlife population loss to a minimum.

H. Ecological Considerations

Basing mitigation on economic factors instead of ecosystems considerations guarantees that ecosystem productivity will not be maintained at the present level unless actions are perceived to be in the Applicants' best

economic interest. Because of the interrelationship between all aspects of the environment, impacts will occur in a chain reaction and be of varied seriousness to all species. For example, the failure to revegetate soil disturbed during the trenching process will be a long-term loss in productivity that will have far-reaching impacts on man and wildlife. A related problem of restoration of soil profiles is the suppression of dust along the right-of-way. In the Great Plains and desert country 20 to 50 tons of soil per acre/year may be lost due to wind erosion.

I. Socioeconomic Values

Impacts that cannot be avoided will be related to those resulting short-term surges in demand for housing, government services, schooling, public safety, food and clothing supplies, recreation and entertainment. Obviously some of these results of construction will be a mixture of negative and positive impacts and all will be more noticeable in smaller communities. It is noted again that the procedure and success of restoration of soil profiles will have a marked result on the extent of crop production that will be lost by farmers along the route.

J. Land Use Planning and Existing Plans

Almost all of the lands along the corridors come under the influence of various plans that influence land use. All levels of government are involved and controls on the lands use vary from zoning to almost no restrictions. The pipeline will cause some restrictions of use along the right-of-way that may be reflected in, for example, development patterns. The proposed route through the large de facto wilderness in northeastern Alaska will eliminate a substantial portion of the area from any future wilderness designation.

K. Archaeological and Historical Values

The lack of knowledge as to detailed archaeological and historical sites along much of the pipeline corridor promises to cause the destruction of some sites. In some instances decisions may be made to go through known sites. In either case the damage or destruction of sites from construction or related activity including vandalism will result in the permanent loss of the site. Salvage is not a satisfactory substitute for site protection.

L. Recreation and Aesthetic Values

Several recreation areas lie directly in the path of the pipeline. Most of these are in the Midwest and the Ohio Valley along the Northern Border corridor. An estimated 1 million recreation visits will either be directed to other recreation areas or not occur at all along this stretch of the pipeline. Because most recreation areas are located in attractive natural areas the loss or damage of the area's aesthetic values may result in long-term visitation impacts that would be reflected in local economic impacts.

Aesthetic values will suffer an incremental loss in those areas where man's presence has had little influence on the natural setting. This will include much of the Alaskan and Canadian segments and the desert country of Nevada and southeastern Oregon and parts of Montana and the Dakotas. Pristine or untrampled countryside cannot be restored to its former condition.

The presence of cleared strips through wooded areas would also affect scenic quality. This will be most obvious in the wooded areas of Canada and in the Pacific Northwest in areas such as the Moyie River Valley in Idaho. The loss of aesthetic values will also adversely affect numerous streams that are under consideration for State or National

Wild and Scenic River status. The pipeline may in some instances mean the elimination of streams from further consideration.

M. Air Quality

During construction fugitive dust (dust generated by excavation, hauling, and backfilling activities) will have an adverse short-term impact on the environment. Most of this impact can be mitigated by conventional construction procedures; therefore it is expected that the Applicants will control fugitive dust.

Compressor station emissions are governed by applicable Federal, State and local agencies. Applicants have stated that they will comply with applicable laws to mitigate exhaust emissions. Reduction of air quality in the Arctic National Wildlife Range will reduce its wilderness characteristics.

N. Noise

During construction, noise derived from heavy equipment, blasting, and aircraft traffic will create interference with

wildlife, birds and humans. This impact is short-term, local and not mitigable. Losses are not definable.

Compressor station noise will have a long-term impact on wildlife. Some species will relocate to less favorable habitat and some loss will occur. Losses are not quantifiable and are incremental. Each facility constructed and developed will create incremental adverse noise impacts. Of special impact is that created by noise in the Arctic National Wildlife Range. The existing wilderness conditions will be lost, possibly never to be returned to the existing pristine wilderness conditions.

O. Repairs

Emergency repairs conducted in the Arctic during the summer season when the active layer is thawed can have a serious impact upon the pipeline and the environment. If excavation of the pipeline is required, the ice bulb in the local area will be destroyed and special measures will be required to provide stability while the trench is open and when the pipeline is put to bed. This is also the worst season as far as much of the wildlife is concerned and particular attention will have to be paid to preventing

adverse effects to the wildlife that are present at that particular season. Care must be taken to assure that repair activities will not disturb the area in such a manner as to deplete great numbers of wildlife and birds. Utilization of conventional equipment will cause extensive erosion problems by disturbing the thermal regime. The Applicant has addressed this problem utilizing current methods of repair, which from the standpoint of minimizing the environmental impact cannot be tolerated. System design should provide sufficient reliability to minimize the probability of unscheduled maintenance on the pipeline, and innovative methods of repair must be designed to accommodate emergency repair activities in the Arctic on a year-round basis which minimizes the effects on the active layer, permafrost and wildlife.

6.0V Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

6.0V.1 Definitions

A. Long-term and Short-term Effects

The effects of the proposed Project would vary in kind, intensity, and in duration, beginning with the first preparatory activity on the route and ending at a hypothetical, indeterminate time beyond its abandonment when natural environmental balances might be restored. Based upon proven natural gas reserves, the present indicated lifetime of the proposed pipeline system is 20 years. The Applicant, in expectation of additional gas discoveries, believes the probable minimum duration of the pipeline to be on the order of 50 years and possibly extending to a maximum of a full century.

As used here <u>short-term</u> and <u>long-term</u> have no precise meaning, the former being taken only to mean the total duration of the Project and the latter an indefinite period beyond its termination, but at least several decades. <u>Short-term</u> effects would be greater during the construction phase than during the longer period of operations and it is convenient to refer to these as <u>shorter-term</u>. Similarly,

longer-term is used for effects which might endure for one or more centuries or, for all practical purposes, be permanent.

B. Environmental Maintenance

The short-term use of environment by the proposed gas transportation system, to provide equally short-term benefits to industrial and domestic consumers of natural gas, cannot occur without some adverse effects. Approval of the Project requires acceptance of adverse effects as a trade-off for the benefits to society of delivery of up to 4.5 billion cubic feet of gas per day. The adverse environmental effects will largely be borne by rural society over the several thousand miles of the system in two countries and the benefits will occur largely to the heavily populated, urbanized, and industrialized segments of society.

In alleviating a critical shortage of clean fuel there must be reasonable certainty that the trade-off in environmental effects will be understood by society and found acceptable. Acceptability should at a minimum depend upon the probability that the system could be built and

operated while maintaining the existing quality of environments it would traverse and affect.

As used here, <u>environmental maintenance</u> means that application of proper design criteria and mitigation measures should preserve the quality of all environmental systems in their natural state off the right-of-way and adjacent to all lands used for facilities for the duration of the Project. The quality of environment over the entire route system varies from pristine wilderness, through various degrees of modification resulting from human activity, to those environments of heavily populated areas that are already much disrupted and, in large part, polluted in terms of atmospheric and aquatic systems.

Maintenance of environment in previously unperturbed areas means that any unavoidable change be subject to recovery in the short-term without loss of environmental values. In areas already disrupted the Project should not impose an added cumulative burden of change that would further degrade environments.

The use of land for the pipeline and related facilities is a short-term commitment of environment and major changes in the shorter term would be unavoidable, as on the right-of-way. Maintenance of environment in these cases is taken

to mean restoration of a stable state in the shorter term, continued management of this state throughout the short term of the Project, and maintenance of the potential for recovery to the natural state in the long term following abandonment. The long-term recovery of the Project area is dependent upon maintenance of environmental quality of this area throughout the life of the pipeline system.

C. Enhancement of Long-term Productivity

Enhancement of productivity applies primarily to man's productive use of energy at the delivery points of the pipeline system. The economic and social benefits would be large for urban areas and, through taxation and other revenues, governments at all levels along the route would benefit. At all points of gas consumption man's environment would benefit by the use of a clean energy source in substitution for fuels emitting high levels of pollutants.

Environments in the gas production fields and along the transportation system would not be enhanced and, even with the best of mitigation procedures, effects must be generally considered adverse, even if minor. Biological productivity would be lost in the shorter term on all lands used by the

system and would be partially restored, except for timber production, on the right-of-way in the short term. Productivity would be withheld for the life of the Project on all lands occupied by such facilities as compressor stations, permanent roads and airstrips, but these too could be returned to productivity in the long term with proper management.

As an exception to the foregoing, biological productivity along the right-of-way could be increased in cleared forest areas by creation of the so-called "edge effect." The rapid growth of secondary vegetation composed of a greater diversity of species and the mix of abiotic environments between open ground and forest would attract and provide food and shelter for a greater diversity of animal species. Such changes, which may be considered to be benefits by many, are trade-offs of one population complex for another.

6.0V.2 Environmental Values Affected by the Proposed Action

A. Ecosystem Values

The proposed pipeline system would cross or otherwise have adverse short-term effects on a large number of North American ecosystems. In the remote northern areas of Alaska and Canada vast areas of the tundra and boreal forest are true wilderness and even larger areas are quasi-wilderness but little modified by man. These ecosystems represent a last resource at large scale of land in its natural state. Southward through the provinces in Canada, and eastward and southwestward along the proposed pipeline system in the conterminous United States, wilderness is a diminishing resource and there is a cumulative threat to the remnant areas of ecosystems in their natural state.

Where the resource remains large the short-term impact on major ecosystems could be small in an overall sense. Although the environmental systems are not well understood and the impact of their disruption cannot be fully foretold, they are probably capable of long-term recovery from pipeline construction and operation measures. The one quality certain to be lost is that of wilderness and this will be a longer-term effect.

The trade-off or sacrifice of some wilderness in the interest of energy supplies can be alleviated by governments in establishing ample protected areas of land at full ecosystem scales and in guarding against intrusions into areas already under protection.

A benefit of opening primitive wilderness country, as viewed by many, will be the improved accessibility which will permit enjoyment of its qualities. Such access, however, will be provided more by public roads, which are either planned or existent, than by the pipeline construction. The two are related, however, and the total environmental cost in the long term will result from the cumulative effects of all developments.

Short-term use would be made of the following major environmental systems.

1) The Marine Ecosystem

The inner continental shelf and the coastal zone of the Beaufort Sea coast of Alaska and Canada would be affected by marine surface shipping, primarily in the shorter-term construction period, and by accidental discharge of fuel oil and toxic chemicals either directly

into the sea or into streams discharging into the sea. Although the ecosystem is in delicate balance--it has a food web which is probably easily disrupted, has two endangered species of whales, and includes other mammals, such as polar bear, which are vulnerable--enforcement of mitigation measures would largely prevent more than minor shorter-term effects. There would remain some threat of cumulative water pollution effects throughout the life of the pipeline system but the ecosystem should not suffer long-term impacts.

2) Freshwater Ecosystems

No major long-term impact on productivity of freshwater aquatic systems of streams and lakes has been predicted by this Environmental Statement. Shorter-term erosion and deposition impacts of the construction period would be transitory at stream crossings everywhere outside the permafrost zone of Alaska and Canada and would be mitigated by erosion control measures. Within the permafrost zone winter construction would avoid impacts of silt deposition on fish spawning beds and, while mitigation of erosion would be more difficult on slopes which become

unstable during warm season thaw, control measures should be effective in a relatively short time.

As with the marine ecosystem, some freshwater systems would suffer the potential threat of the cumulative effects of spilled fuels and toxic chemicals. Streams of northern Alaska and Canada would be most affected and especially the latter, due to the necessity of utilizing river transportation and establishing wharves and stockpiles along the Mackenzie River.

Although it is possible that individual lake or small stream ecosystems would sustain disruptions that would impair productivity into the long term, the incidence or magnitude of such events would not threaten the freshwater ecosystem resource of the regions traversed. These infrequent occurrences could only be accepted as a trade-off for the value of the transported natural gas if the system is approved.

3) Terrestrial Ecosystems

Short-term use of the large number of terrestrial ecosystems that would be traversed would principally have short-term impacts, and long-term recovery would occur by

natural processes even on the right-of-way and restored construction sites. Recovery rates would be slow in the arctic tundra and in the western deserts but the return to a natural state would be accomplished if not impeded by cumulative impacts of other types of development. The unavoidable loss of wilderness values which are associated in large part with terrestrial environments will, as previously mentioned, be a longer-term or permanent effect.

The loss of any biological component would forever change the character of ecosystems. All threats to endangered species and to the loss of wilderness values will be considered by large numbers of people to be unacceptable long-term consequences of short-term use of the environment.

B. Ecosystem Component Values

1) Climate

The proposed Project would have no effect on regional climates. Locally, around compressor stations in the Arctic and subarctic, water vapor would at times create ice fog which could impede aircraft traffic.

2) Topography, Geology and Surficial Soil Materials

Most of the changes in topographic and geologic conditions would have short-term effects on the environment but no appreciable long-term effects. Accelerated erosion and sedimentation of streams would be greatest during the shorter term of construction but relatively minor thereafter. Slope modifications caused by landslides that might be initiated by pipeline construction, especially in mountainous and permafrost terrain, would be long-term effects as would be the development of thermokarst topography by thaw of ice-rich permafrost. Scars on the terrain would heal in the long term but the process would be slower in the tundra and desert than elsewhere.

Consumption of natural gas would be an irretrievable loss of a geologic resource which might be needed at a later time for more valuable use. Heavy requirements for gravel in permafrost regions would commit a scarce resource to short-term use and foreclose options for future use. Although some gravel might be reclaimed for future use much of it would be disturbed in such a way that its recovery would not be feasible.

Soil productivity would generally be adversely affected by trenching, filling, compaction and erosion on the right-of-way, and reduction in soil fertility would impede both natural revegetation and agricultural crops. There is some evidence that the physical properties of certain agricultural soils of Canada are improved by excavation and backfilling. Some 25,000 acres of productive agricultural soils along the proposed rights-of-way in the conterminous United States would be affected by construction but rehabilitation measures would be expected to bring them back into production within two or more years.

3) Air Quality

Large numbers of construction machines would locally pollute the atmosphere in the shorter term and products of combustion would be emitted continuously by compressor turbines for the duration of pipeline operation. In the Arctic the air is probably free of industrial pollutants and in the conterminous United States it is degraded more in the East than the West. Noxious gases would cause a greater fractional degradation in the North and West but concentrations would be within limits of

government standards and would have minimal impact on air quality and no long-term effect in most areas. In the Arctic and subarctic chronic exposures to sulfur dioxide might kill lichens which are sensitive to this gas and interfere with an important winter food supply of caribou. The probability is not great, but should lichen kill result the consequences could extend into the long term.

A pipeline break could release 100 million cubic feet of gas and create a hazard in populated areas but it would be rapidly dissipated by dilution in the air and have only transitory effects. In such a case fire would be a greater hazard than deterioration of air quality.

Air contamination by particulate matter would occur as a shorter-term effect. Some soils of arid and semi-arid regions of the western and northwestern United States are highly susceptible to wind erosion. Construction machines working along the vegetation-denuded right-of-way would cause major dust problems of a local, transitory nature. Until these areas were restabilized by vegetative cover, wind blown dust would be a continuing source of degraded air quality.

4) Water Quality

The primary consumption of both surface and groundwater would be related to construction activities. Since the construction period is considered to be shorter-term, these uses of the water resources would not be expected to affect long-term productivity. The amount of water required for operation and maintenance of the pipeline would be small in comparison to the amount available, and thus no long-term effects beyond the lifetime of the project would be expected.

The increase in suspended and bedload sediment would primarily occur during construction. Erosion control measures proposed for stabilizing stream channels and hillsides after disturbance should reduce long-term channel and upland erosion.

Although there is potential for long-term impact on water quality because of waste disposal in northern areas that are now uncontaminated, the use of secondary treatment methods and sewage lagoons should ensure no serious alterations to the quality of water resources.

As previously indicated, failure to control spills of fuel oil and toxic chemicals could result in long-term

cumulative degradation of water resources and their biological populations in northern Alaska and Canada.

5) Vegetation

No significant changes in plant communities would be induced by the proposed project, assuming the probable success of the mitigating measures available. The short-term effect would be the commitment of the acreage of the right-of-way, permanent roads, airstrips, and other facilities to project use and to vegetative change varying from total destruction to minor disruption. In terms of the large areas of all kinds of plant communities, the losses by short-term use of required acreage would be small and no community type would be threatened.

The shorter-term effects would include destructive practices of tree and tall shrub removal, and, in permafrost regions, disruptions to the insulating moss-peat mat and compression of this mat where not otherwise damaged. Recovery of lightly damaged areas would take place in the short term and revegetation programs would initiate erosion control that would be continued by natural succession of native communities. The short-term effects on the right-of-

way in forested areas would be the prevention of the regrowth of trees and tall shrubs.

In the long-term, all vacated and abandoned areas would be expected to recover fully and develop natural communities typical of specific geographic regions. The productivity of vegetation would not be impaired off the right-of-way and the short-term use of land would not prevent restoration of its productivity in the long term.

Some endemic plant species occur on the proposed routes and others are considered endangered. It is improbable that any of these would be eliminated by the right-of-way or facilities but the risk exists and the habitats of such species should be avoided.

6) Wildlife

a) Fishes

Short-term effects of the proposed project would principally be siltation of spawning beds, depletion of oxygen in over-wintering lakes and streams, blockage of migration, introduction of toxic chemicals and increased human access to sport-fishing stocks. Control of erosion would hold siltation to the short-term in most areas, but in

the North side-slope instability in some areas of ice-rich permafrost would extend this problem into the long term. High turbidity levels in the short term could seriously diminish the biological productivity of the entire aquatic ecosystem although longer-term recovery would be probable if only a few streams or lakes were affected.

Rigorous control over introduction of organic wastes and toxic chemicals could avoid the threat of oxygen depletion and poisoning of fishes or organisms of their food chains.

Human access to fishing resources, either for sport or commercial fishing, would be a minor concern insofar as construction or operation of the proposed pipeline is concerned. The greater number of people who would follow, more as a consequence of highways independently constructed, would pose a long-term threat to fishing stocks and to subsistence fishing of Native peoples. Increased sport fishing opportunities would be a benefit to many people.

Mitigating measures would prevent, control or correct most of the effects of the proposed pipeline on fishes, but during the short term there would be continuing threats of unpredictable magnitude to some populations.

Maintenance of productivity in some cases would be improbable and in no case is any enhancement of the environment or increased productivity of fishes foreseen.

A few endangered species of fishes have been identified in this draft statement. Such species which are near extermination could be further adversely affected by the proposed project.

b) Birds

Birds are not only important elements of ecosystems, but sources of pleasure to large numbers of people who study their habits or engage in hunting of game species. They are a valuable resource and any threat to song birds, waterfowl and birds of prey or others is vigorously resisted by concerned citizens. All segments of the proposed pipeline system have rare and endangered species which could be further jeopardized through direct mortality, destruction of habitat and disturbance by all forms of human activities.

While the acreage of natural bird habitat disturbed within the right-of-way would be relatively limited, it would be one more threat additive to road and powerline construction, stream alterations, wetland drainage, urban expansion, and other activities as

disruptive influences. Right-of-way clearing in heavily forested areas could, however, increase the biotic diversity and productivity, including many kinds of birds.

Effects of the Project would be especially critical in northern Alaska and Canada where wilderness conditions prevail and provide the resources supporting an enormous international population of breeding ducks, geese, swans, raptors, and sandhill cranes, among others. All disruptions to nesting, feeding, molting and staging activities of migratory species either on the far northern breeding grounds or along the flyways would have critical effects on productivity and survival.

The Arctic National Wildlife Range in northeastern Alaska and a similar proposed range in the adjacent Yukon Territory of Canada are critical areas for summer-resident birds. Both of these areas would be crossed by the proposed pipeline route.

Mitigating measures, such as winter construction, would avoid contact with migrating and nesting populations during the shorter-term construction period. During short-term operations, aircraft disturbance to birds would be severe without controls and uncertain in total effect if recommended altitude and flight paths were

maintained. Lack of roads in the North places heavy reliance on aircraft for pipeline maintenance and surveillance and the threat to birds would continue for the life of the Project. Snow geese are especially susceptible to disturbance by noise of aircraft and compressor turbines. Barge traffic on the Mackenzie River and along the Beaufort Sea coast would disturb birds and, together with stockpile sites, would constitute an oil spill hazard to birds.

By proper scheduling, route selection, and avoidance of harassment the long-term productivity of bird populations could be maintained. This applies also to raptors, including the endangered peregrine falcon, whose habitat could be avoided and to which only human presence and molestation would be a disturbing factor.

The proposed project would provide no enhancement of bird productivity in the North but, on the assumption of the success of mitigating measures, could permit its maintenance. Even though certain species of birds would be affected adversely locally, the probability is low that the overall productivity of bird populations over the length of the proposed Prime Route would be affected significantly during the lifetime of the proposed pipeline. The greater threat would be the cumulative

effects of all developments such as new oil and gas fields, including off-shore in the Beaufort Sea, highways, and increased access to sport hunting and other human activities disturbing to birds. Avoidance of prime bird habitat everywhere along the pipeline system would afford the greatest amount of protection against long-term effects on birds.

c) Mammals

As with birds, mammal productivity is affected adversely by destruction of habitat, pollution, direct mortality by increased hunting pressure and vehicle collisions, harassment by man, and by noises such as compressor turbines or overflying aircraft which alter their patterns of behavior and may drive them from parts of their range. Right-of-way construction would remove only a small part of the total habitat resource of large game species in primitive areas but would add a significant incremental loss of habitat in the more heavily populated and agricultural areas. The right-of-way when revegetated could attract small mammal populations and their predators.

Rare, endangered and highly vulnerable mammal species occur along all parts of the proposed pipeline system and long-term impact will be difficult to avoid.

Some of the last North American wilderness in Alaska and Canada supports balanced populations of valuable species such as grizzly bear, caribou, wolverine, moose, Dall sheep and wolf which may be readily disrupted by the pipeline system and other developments present or to come. Many species have large home ranges and are intolerant of human encroachment. Bears are attracted by waste disposal around human habitation and come into conflict with man. Uncontrolled shooting either in the name of safety or hunting would take a heavy toll of game animals as man gains greater access to wilderness and quasi-wilderness areas.

The international Porcupine Caribou herd would be vulnerable to interference with its autumn and spring migrations, and to hunting, vehicle collisions, and noise and harassment on the calving and post-calving grounds which lie within the Arctic National Wildlife Range of Alaska. Winter construction would avoid the herd and other pipeline impacts could be mitigated without long-term effects on the herd. It must be anticipated, however, that the cumulative impact of the pipeline system and all other developments will impose continuing long-term attrition to many mammalian species and a loss of their enjoyment by future generations.

d) Other Animals

The pipeline system would probably have little long-term effect on productivity of most groups of animals other than those previously mentioned. There are large numbers of animals of small size, such as insects, that are characteristic of specialized habitats and which play important roles in all ecosystems. The pipeline would affect these only if destroying a restricted very specialized habitat, by pollution or by use of pesticides. On the West Coast routes some fifty species of insects are known which could be lost through destruction of their sand dune habitat. Rare and endangered species occur in most animal groups, as reptiles and amphibians, and the only protection is to avoid their known habitats.

7) Man

The short-term effects of the gas transportation system on industrialized man will be maintenance of economic productivity and the opportunity to develop new energy sources, or scale down energy consumption, for the long term future. Socio-cultural effects would probably be minimal but economic stability could do much to maintain social

stability. A long-term benefit to man's environment could be enhancement of an environmental ethic which would lead to protection of existing environments and correction of the pollution effects of the past.

Human populations which are subject to the most radical short-term as well as long-term consequences of the Project are those Natives of Alaska and Canada who live closely with the natural ecosystems and depend upon their resources for subsistence, cultural satisfaction and prestige. In Alaska only one small Eskimo community, Kaktovik, would be affected, and in Canada about 25 villages.

a) Economic Effects

The proposed pipeline during its construction phase would provide temporary, mostly unskilled jobs to a majority of employable males. The positive effects of significant cash income would represent large benefits to the individuals, families and communities. The benefits would be temporary and might be offset by dissatisfactions arising from decline of jobs at the end of construction. Job training opportunities would prepare Natives for employment in about 200 permanent jobs in Canada.

A subsistence economy based upon hunting, trapping and fishing is important in all but the largest more urbanized communities and some individuals and families depend on resources of the land in all communities. Sea mammals, caribou, wolf, wolverine, muskrat, beaver, mouton and fox, among others, are important sources of food and clothing or products for barter or cash income. Any short-term effect destroying animals or their habitats or which would drive important subsistence game beyond access of the village residents would have long-range deleterious effects on the subsistence economy. Although mitigation of many of these long-range effects is possible and will be attempted there can be no assurance of their success. The history of the introduction of highways, pipelines, power lines and people who follow lends no optimism to the continuance of a viable subsistence economy. Such a long-term trade-off should only be made with the full understanding and consent of the people affected.

b) Socio-cultural Effects

The Natives of northern communities have long been exposed to white man's culture and the social evolution that has already changed their traditional ways of life can only be accelerated by the development and transportation of

mineral resources in the North. Many people will welcome the benefits of a new life style and different social customs but in the short term and perhaps the long term many will desire to retain their traditions, customs and language. Whether the changes are good or bad are value judgments only the people concerned can make and the options should be of their choice.

8) Archaeological and Historical Values

The proposed construction would have a short-term impact on archaeological resources through the accidental destruction of sites before they could be identified and protected. Long-term knowledge thus would be reduced to the extent that the materials lost would not be available for the interpretation, education, and enjoyment of future generations.

Sites discovered and properly investigated before construction would add to the long-term production of knowledge of our heritage. Once an archaeological, paleontological, or historical artifact is discovered in place, its long-term productivity is just beginning. During construction, some sites might be located that could have

enough interest and significance to warrant permanent protection and become points of interest and public attraction. The most important value, however, in relation to long-term productivity, would be the information gained which could lead to the location of other sites and the advancement of knowledge of early man and his history.

9) Aesthetic Values

During construction aesthetic qualities of the environment would be degraded by the presence of large numbers of workers and their machines and the consequent noise, smoke and dust. The right-of-way would be a short-term scar on the landscape which would have a large visual impact especially as viewed from the air or from highways and streams near crossings of elevated terrain. Its linear, relatively straight path would be a discordant note on all landscapes not otherwise affected by road and seismic line patterns. Revegetation would ameliorate the impact but color and texture differences would make it apparent for the life of the Project. Revegetation would be slow in tundra and desert areas and the scars would be visible indefinitely into the long term following abandonment. Clearing of trees

and tall shrubs for the duration of the pipeline would produce tunnel views in forest areas and scars which would be long-term costs to scenic values.

Structures of all types would mar the visual quality of all areas not previously marked by the works of man; true wilderness quality would be destroyed and quasi-wilderness further degraded. Compressor stations and communication towers would be especially discordant on treeless areas of low relief as in the tundra and parts of the desert. Vapor plumes at compressor stations would be visible for many miles in areas of low relief and would be especially frequent and conspicuous in the Arctic and subarctic. Aesthetic qualities would be restored in the long term but many decades would be required before natural processes would obliterate the scars.

10) Recreation Values

Short-term effects of construction and operation of the pipeline system on recreation would be relatively insignificant in the conterminous United States and those parts of the Canadian provinces where access is already essentially unlimited. During construction all previously

mentioned activities which affect aesthetic quality would temporarily restrict outdoor recreational pursuits. Where it might be necessary to close parks, recreation visits would be shifted to other areas, or the experience missed. Long-term visual effects would detract from scenic viewing and photography.

Temporary deterrents to recreation would include restrictions to travel; disturbance to birds and other wildlife; suspension of boating and fishing at or near stream crossings, due to presence of construction equipment and increased water turbidity resulting from trenching and run-off from cleared areas; and noise and dust of construction activities. For the duration of the Project increased noise would have an impact upon developed recreation areas located within two miles of compressor stations and gas blowdown sites.

In primitive areas effects would be both positive and negative. Long-term use of airstrips and roads built for the system as well as roads built by governments would improve access to remote areas and bring camping, backpacking, hiking, fishing, hunting, canoeing and other recreational resources within reach of greater numbers of people.

Wilderness values would suffer the greatest deterioration, both by the presence of the right-of-way, permanent facilities, and overflying surveillance and maintenance aircraft of the pipeline system and by the influx of recreationists themselves. The loss of opportunities for finding solitude and quiet and for observation and enjoyment of wildlife in the natural state would be a long-term, continuing cumulative effect of all developments.

The crossing of river segments designated as potential additions to the National Wild and Scenic Rivers System could affect these rivers' ultimate classification and management. Wild and scenic river values destroyed would be lost indefinitely to present and future generations.

While it may be possible to transmit natural gas from Alaska's Arctic Slope by several different routes, wilderness can neither be created nor transported, and loss of the wilderness character of the area within the Arctic National Wildlife Range or other wilderness would be a long-term loss of the productivity and enjoyment of that resource.

11) Health and Safety

The major health and safety problems would be encountered during the construction shorter-term period and would be mainly those associated with a large number of people and machines working in close proximity to each other, movement of a large number of vehicles, and the handling of a large mass of materials. All work around heavy construction machinery is hazardous, and the arctic and subarctic environments, with their extreme cold, slippery surfaces and long periods of darkness, will take a toll of human life and health during the several years the pipeline is being built. After the construction period, some hazards will continue for the small group of persons involved in operating the pipeline system, especially in the Arctic.

Potable water supply and sewage disposal for the construction force would be short-term problems which should have no long-term impacts on human health and safety. Attraction of bears to camp sites by food odors and careless handling of waste could lead to confrontations and some hazard to workers.

The possibility must be considered that a rupture in the pipeline or other failure in the system could occur.

In this event a hazard to the health and safety of populations located in the pipeline vicinity could develop. The seriousness of the hazard could range from insignificant to catastrophic. The likelihood of such an event and the conditions under which it could occur are unknown. Although this hazard may be extremely small, it is nevertheless a long term possibility that would not exist in the absence of the pipeline.

Whether or not a safety hazard will exist after project abandonment would depend on the degree and effectiveness of salvage operations. Residual debris such as metal scraps could constitute a long-term hazard. Also, if the pipeline were not removed cave-ins and the attraction to children to "explore" the pipe could constitute safety hazards in the long-term. Complete removal of the pipeline accompanied by rehabilitation of the right-of-way would avoid the great majority of these risks.

12) Agriculture

Individual farmers and other land owners will have to endure a number of shorter-term nuisance type impacts during construction. These include disruption of farming

activities, interference with drainage systems, noise and air pollution and barriers to farm and service center access.

Several million dollars of crop production would be lost during a minimum of one construction year. While losses to individual farmers would be small in relation to total farm production the cumulative loss at a time of world food shortages is important. Several hundred thousand bushels of major feed and grain products would be lost to North American food production. Depending upon the degree of mitigation an equal loss might be incurred during the following 2 to 3 year period because of lasting impacts to the soil resource.

6.0V.3 Restrictions to Future Options and Needs

A. Land Use

The right-of-way and land occupied by ancillary facilities would be unavailable for other use during construction. During the short-term operation of the Project much of this land would be available for other uses. Some uses, such as grazing and agriculture, would be the same as before initiation of the Project. Forest productivity would be lost for the duration of the Project. Long-term productivity beyond the lifetime of the Project would be unaffected except the loss of wilderness values. Some pipeline-related facilities could be put to other uses. Construction material sites used as borrow pits and quarries might be so depleted as to have no value as future sources of such material.

Construction of the proposed pipeline would probably encourage further development in the Canadian Northwest and northern Alaska and thus further disrupt the wilderness. Increases in population would also increase the pressures on wilderness and recreation resources. There would be significant long-term impacts on the use of the land of the Alaska Arctic Slope. The pipeline would preclude the designation of that area as a unit of the National

Wilderness Preservation System. The aggregate impact from development of additional natural gas sources would further undermine the objectives for which the Arctic National Wildlife Range of Alaska was established and have similar effects on the proposed Wildlife Range in the adjacent Yukon Territory. Several proposed research natural areas would lose their long-term value as productive contributors to our knowledge of tundra ecosystems. These cannot be re-created after the pipeline is abandoned in 20 to 50 years.

While construction of the pipeline system would negate the area's wilderness status, the new transportation and communication facilities would make the area more attractive to many people, and the present light recreational use would become heavy, exceeding the threshold of tolerance to disturbance of many arctic plants and animals. Construction-caused disruption of drainage systems could cause permanent damage to scenic streams and waterfalls along the route, affecting public appreciation of the region.

Long-term impacts on recreation resources and general productivity of the environment would result if the pipeline caused permanent damage to sport fisheries or game animals. In primitive northern areas increased sport fishing could

have adverse effects on the limited potential for commercial fisheries. All adverse effects on biological resources would have long-term consequences on the subsistence uses of land by Natives.

Existing pipelines in much of the area that would be affected by the Project have imposed safety, legal and noise avoidance restrictions on land use. These effects would be reinforced or intensified by an additional pipeline and would add a new consideration to land use where this pipeline would be the first.

In the long term following salvage or abandonment of the Project, land would revert to the owners from which its use was obtained and would be integrated into the then existing agricultural, urban, suburban, commercial or other type of land use.

B. Acquisition of Mineral Resources

Short-term production of natural gas would consume the resource in about 20 years and preclude any long-term productive use. However, the construction of the proposed pipeline system would also encourage exploration and

development of nearby areas thought to contain economically available gas reservoirs.

If additional supplies of gas were discovered and developed either on land or in the Beaufort Sea, the proposed pipeline would enhance the production from such fields.

On the Arctic Slope the Arctic National Wildlife Range and Naval Petroleum Reserve No. 4 are considered likely to contain significant petroleum reserves which if developed would limit future options for long-term energy and petrochemical uses and also nullify the special purposes for which these areas were established.

The geologic resources that would be unavailable for extraction and consumption are those that would directly underlie and support the right-of-way, plus those that must be left to maintain stability of these supporting materials.

Those geologic resources most directly affected are those that are normally extracted by stripping, pitting or quarrying and which would be traversed by the proposed route. These resources mainly consist of lignite coal, sand and gravel, decorative stone and crushed rock. Future demands in the resource market may add sodium sulfate, clay and shale, industrial sands and perhaps peat.

The quantity of material that would be lost is negligible in terms of the total of each resource that is present adjacent to most of the route. Nevertheless, in terms of some individual deposits of sand and gravel, the quantity would be great. Extraction and consumption of sand and gravel in permafrost regions of Canada and Alaska would be very great in relation to available supplies, especially on the North Slope. Commitment of this resource to the Project would impose significant restrictions on future acquisition for other uses.

Acquisition of geologic resources situated at depth beneath the right-of-way probably would not be affected. Much of the bituminous coal, probably all petroleum and natural gas and salt, for example, are at considerable depth. These could be extracted by wells or underground mines for which ground-surface operations need not be located in the right-of-way area.

Acquisition of lignite coal resources by other developers could occur as a result of pipeline construction. The coal would be acquired for use in a coal-gasification process to yield gas which could be transported to market by the proposed pipeline.

Acquisition of some remote geologic resources, either in place or already extracted, and either in raw or processed form, would be necessary in order to provide materials of various kinds required for pipeline construction. For example, several million tons of steel would be required for the pipe alone.

Most of the geologic resources used in construction of the pipeline would not be available for use elsewhere and other needs in the two countries would have to be met by the acquisition of new, different or additional resources for extraction and consumption.

C. Availability of Fuel

The known and committed reserves of natural gas to be transported by the proposed pipeline are sufficient for about 20 years at design capacity. The pipeline could also reasonably be used to transport natural gas from other large known and potential reserves in Alaska and northern Canada and synthetic gas manufactured from the vast coal deposits of Montana and the Dakotas, which would extend the life of the pipeline to 50-100 years. Therefore, the increased

availability of fuel to the U.S. and Canadian delivery areas would be long-term.

The fuels and lubricants used in construction of the proposed pipeline would be a significant short-term diversion of petroleum products from other uses. Operation of compressor stations to transport gas would require use of significant amounts of the fuel. For example, about 15-20 percent of gas entering the pipeline system at Prudhoe Bay, Alaska, would be consumed by the time the gas is delivered to consumers at the end of the 6,000-mile system. Such use is a long-term loss of a non-renewable resource which could be used nearer its source at a future time.

6.0V.4 Benefits of Energy Supply Made Available as a Result of the Proposed Action

Numerous economic, political and social benefits would accrue from a plentiful supply of relatively cheap and clean energy. Most of these benefits would be of a short-term nature and would affect the populations in the conterminous United States and southern Canada more than the Native peoples and others in the immediate project area. The major benefit would be a short-term decrease in dependency on energy sources which are subject to politically motivated interruption. At best, implementation and completion of the proposed pipeline would provide short-term, critically needed energy and perhaps provide time either for the development of long-term alternative energy sources and substitutes for petrochemical feedstocks or reductions in their levels of need.

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7.OV Irreversible and Irretrievable Commitments of Resources

Introduction

The purpose of this chapter is to describe, in summary form, those resources that will be irretrievably lost through the implementation of the proposed project. Resources as referred to in this chapter include not only the materials and labor required to construct the pipeline and related facilities, but also the natural and cultural values that may be lost permanently as a result of project implementation.

7.OV.1 Damages From Natural Catastrophic or Man-Induced Accidents

Natural catastrophic or man-induced accidents could occur along the pipeline route resulting in rupture of the pipeline. A rupture in the pipe would cause a loss of natural gas, possible destruction of wildlife and vegetation, loss of materials, and a possible loss or damage to human populations and surrounding property.

In a typical area a pipe rupture is estimated to cause a loss of approximately 280,000,000 standard cubic feet, based on pipe volume and the time to manually close main line block valves. Automatic closing may reduce this loss to nearly 160,000,000 standard cubic feet. The heating value of this gas is approximately 280 billion and 160 billion British thermal units (Btu), respectively. The former amount is sufficient to heat 140,000 homes for one day.

If an explosion of low lying gas occurs, there will be an irretrievable loss of vegetation and wildlife in approximately a one-half mile diameter circle. Without explosion it is unlikely that any loss will occur.

For a pipeline rupture under outside force conditions, it is likely that only one or two pipe sections would be irretrievably lost. If a weld failure occurs, it may be

necessary to replace many sections depending on the cause of failure. If failure occurred at a compressor station and ignition occurred, which is likely, the entire station could be destroyed. This would result in irretrievable loss of all station materials.

A slow leak in a high pressure line would be equivalent to some of the leaks which have caused devastating explosions in the recent past. Being a slow leak means the detection time is long giving the leaking gas ample opportunity to accumulate large quantities. Unlike most of the previous accidents, a transmission line does not directly serve homes, so opportunities for accumulation in closed structures is remote (except for compressor stations). In addition, it would appear that the possibility of a slow leak is more remote in very high pressure lines because of the large forces involved. Thus damage to humans or structures from slow leaks is a less likely event than those from catastrophic releases.

To estimate damage from a catastrophic failure of a pipeline would require explicit knowledge of micrometeorological conditions and the time to ignition. Experience with damage caused by large high pressure gas lines is limited, fortunately. The Mobil Oil Corporation's

780 pounds per square inch pressure, 14 inch diameter pipeline failure in a residential district near Houston, Texas on September 9, 1969, is one such event. After 8 to 10 minutes of gas release, the explosion destroyed 13 houses ranging from 24 feet to 250 feet. A total of 106 homes were damaged and property damage was estimated at $500,000. No one was killed in this incident.

Based on only this one incident, a total damage radius of 250 feet and a partial damage radius of 600 feet can be established.

7.OV.2 Project Structures Unlikely to be Removed

The manner of abandonment of this project, except in Canada, will be determined by the Federal Power Commission in accordance with Section 7(b) of the Natural Gas Act, 15 USC 717f(b) and in accordance with regulations of the Office of Pipeline Safety, and will probably have to conform to regulations developed in the interim period. The Applicants have stated that all above ground structures can be removed and the pipeline could be removed if it is necessary to accommodate future construction. If and when abandonment becomes necessary, the pipeline will be removed and the pipe trench will be restored to original contour with material from the right-of-way, from borrow areas agreed upon with landowners or from commercial sources.

It appears, then, that all project features will be dismantled upon eventual abandonment and only those materials which are impractical to recover will be discarded. With the rapid reduction of world resources, it appears likely that the steel in the pipeline, compressor stations, and other features will be recovered and reused. The only material to be lost is likely to be lumber, cinder block, concrete, and asphalt. A loss of materials from

borrow areas would occur to refill the trench since the originally removed material will not be available.

7.OV.3 Resource Extraction

A. Natural Gas Resources to be Used

The proposed pipeline projects would transport the natural gas resource discovered in the Prudhoe Bay area of Alaska. The proven reserves in this area of Alaska are estimated to be 26 trillion cubic feet. In addition, 7 trillion cubic feet have been discovered in northwestern Canada. In addition to these proven reserves, speculative recoverable reserves have been estimated by the State of Alaska in the Alaska Open File Report Fifty issued by the Division of Geological and Geophysical Surveys (DGGS) of the State of Alaska in June 1974. The DGGS Report states that "speculative recoverable petroleum resources are here defined as those petroleum resources which are completely undiscovered, and which after discovery can reasonably be expected to be produced using present technology and economic conditions." The figures in Table 7.OV.3-1 are taken from that report for geological basins or provinces which we believe, once such reserves are drilled and proven, will be within economic range of the Alaskan system projected by the Arctic Gas group and should ultimately be delivered through that system to the United States.

Table 7.OV.3-1

Speculative Gas Reserves in Alaska

North Slope Onshore	41.8 trillion cubic feet
Beaufort Province Offshore	13.5 trillion cubic feet
Chukchi Province Offshore	33.0 trillion cubic feet
Total	88.3 trillion cubic feet

It is not possible to use the same approach for Canada as is employed in Alaska in estimating the volumes of natural gas which the United States might anticipate from Canadian discoveries. The reason is that no gas can be exported from Canada into the United States without a determination by the Canadian Government through the National Energy Board that such gas is surplus to the requirements of Canada, and it is impossible to predict what the future requirements and supply picture in Canada will be as determined by the National Energy Board and thus impossible to predict what volumes of Canadian gas may be available. Some natural gas pipeline companies have letters of intent with Canadian producers in the Mackenzie Delta for delivery of Canadian gas. It would not be unreasonable to assume that at least some of this gas and some gas to be developed in the future would be made available to the American market by Canada, giving consideration to the fact

that exploratory efforts are at only a preliminary stage in the Mackenzie Delta, and have barely begun in the Arctic Islands and offshore eastern Canada. At least some additional Canadian gas may become available as surplus to Canadian needs from future development of these sources. To the extent that the Mackenzie Delta area (and possibly the Arctic Islands) was designated as the supply source of such surplus gas, the gas could become available to the United States for transmission by the proposed pipelines.

B. Other Fossil Fuels That Would be Used

One pipeline, the Northern Border, will permit easy access to the Dunn Center, North Dakota coal fields, which the Applicant states may be utilized for coal gasification and injection into the line. No data are available on the magnitude of such a project. A newspaper report on December 14, 1974, in the Bismarck Tribune (North Dakota) stated that the Natural Gas Pipeline Company proposed to strip mine about 52 million tons of lignite coal per year to produce 365 billion cubic feet of synthetic natural gas per year. Over a 20 year period there would be an irretrievable loss

of about 1 billion tons of coal from the North Dakota fields.

C. Oil and Gasoline for Project Vehicles and Machinery

A significant amount of diesel oil, gasoline, and lubricants will be required by the equipment and machinery used in construction of the project's key features: mainline, river crossings, compressor stations, and microwave towers.

The major items to be consumed and the estimated quantities of each are shown in Table 7.OV.3-2.

Table 7.OV.3-2

Petroleum Products to be Consumed by Construction Vehicles and Machinery

Item	Quantity
Gasoline	30.5 million gallons
Diesel Oil	70.6 million gallons
Lubrication Oil	1.3 million gallons
Grease	800,000 pounds

D. Mineral Resources to be Used by the Project

There are several major mineral resources to be used by the project. The impact on geologic resources would be the consumption of natural construction material for access roads. This would be an essentially irreversible and irretrievable commitment, as would be the terrain modification caused by use of sand and gravel borrow areas and rock quarry sites. The locations and extent of such sites are not available.

Other mineral resources to be used by the project include concrete, bedding material (approximately 2,000 cubic yards per mile), and bituminous material for roads.

E. Non-Renewable Resources to be Used by the Project

The construction of the pipeline will require large amounts of resources which would be irretrievably and irreversibly committed. The major items to be committed are shown in Table 7.OV.3-3.

Table 7.OV.3-3

Non-Renewable Resources to be Committed to Pipeline Construction

Natural Gas	88+ trillion cubic feet
Diesel Fuel	70.6 million gallons
Gasoline	30.5 million gallons
Lubrication Oil	1.3 million gallons
Grease	800,000 pounds
Welding Rod	21.7 million pounds
Bituminous Material	10.8 million gallons
Concrete	376,440 tons
Gravel	12.5 million cubic yards
Steel	5.9 million tons

The steel pipe could be re-useable if it is removed in the event of pipeline abandonment. The sale of the pipe for specific uses will depend on a need at the time of removal, but it is impossible to predict an after-use at this time for that quantity of pipe. The condition of the pipe at the time of removal could be a condition of whether re-use is practical. Transportation cost could be prohibitive.

7.OV.4 Erosion

The principal impacts of the proposed project on wind and water-related erosion would be through (1) extraction of sand and gravel from stream channels, from sites near channels, and from hillside borrow pits; (2) altered landscape features resulting from construction activity; (3) induced accelerated wind and water erosion due to clearing of the right-of-way, including thermokarst developments; and (4) altered microdrainage patterns within and adjacent to the pipeline area. These impacts would affect the long-term water-related environment and be a type of irreversible and irretrievable commitment. However, it is extremely doubtful that any commitments of the water resources by the proposed project would be considered as irreversible and irretrievable.

Erosion would cause short-term and some potentially moderate long-term turbidity increases in streams and lakes, as well as siltation of spawning beds and fish nursery areas. Mitigative measures should control long-term changes of these types and there would be no irreversible or irretrievable effects on aquatic ecosystems in general, or fish specifically.

7.OV.5 Destruction of Cultural, Archaeological, Aesthetic, Scenic and Historical Sites

It is likely that some unidentified archaeological or historical sites would be damaged or destroyed during construction of the proposed project, but their number and value cannot be estimated. Archaeological evidence is a very limited and irreplaceable resource. It is easily destroyed and once gone, is lost forever. However, it is probable that the loss would be mainly to knowledge of the local cultural heritage and not to continent-wide archaeological interpretation.

Although historic sites themselves would not be damaged by construction and operation of the proposed project, aesthetic damage to the nearby landscape in the form of alterations of the natural topography could detract from visitors' enjoyment and appreciation of such places.

7.OV.6 Elimination of Endangered Species Habitat

Construction and maintenance of the proposed pipeline project will have both a short-term and long-term impact on endangered species habitat. This impact could result in an irreversible and irretrievable commitment of a valuable wildlife resource.

Possible commitments include the loss of cover in nesting, feeding or breeding areas; abandonment of nesting trees caused by the cutting of these trees or by the pipeline passing close to them; damage to aquatic habitat; noise and air pollution; and the possible loss of threatened, unique, and/or endangered species.

The unique, threatened, and/or endangered species which will have their habitat damaged or eliminated include peregrine falcon, prairie falcon, bald eagle, golden eagle, bighorn sheep, Ord's kangaroo rat, giant garter snake, shaptor salamander, Indiana bat, Lost River sucker, shortnose sucker, and rough sculpin.

Losses of unique, sensitive, and endangered plants and animals would represent both irretrievable and irreversible resources that provide pleasure and education to man and variety to the ecosystem.

7.OV.7 Irrevocable Changes in Land Use

The proposed pipeline will affect land use both on the right-of-way and adjacent to the right-of-way due to considerations for noise and safety. The existence of the proposed pipeline would inhibit the conversion of lands from uses such as agriculture to residential or industrial uses.

The presence of the pipeline will definitely inhibit the development of communities along the proposed route. Apart from the direct loss of land, the presence of the proposed pipeline will pose a visible interruption to the landscape and existing land uses. There is a potential threat of explosion which will cause a secondary obstacle to development.

Construction of the proposed pipeline would have irreversible and irretrievable effects on outdoor recreation resources along the proposed route. Landscape scarring and disruption of the natural scenery would last at least the life of the project, and in some areas, particularly the Arctic coastal region, the visual impact of the proposed project would remain much longer. This would be an irreversible commitment of one aspect of the resource that recreationists use.

The indirect effects of increased human population in the region, and increased human intrusion on wilderness or roadless areas would be irreversible impacts on existing recreation resources. Changes in existing patterns of human use and resource allocation stimulated by construction of the proposed project would irreversibly change the existing atmosphere of the area, thus impairing part of its appeal to outdoor recreationists.

7.OV.8 Commitment of Materials and Human Resources

The commitment of materials has been previously discussed in this chapter. There will be a commitment of labor during the construction in excess of 15,000 man-years. It is virtually impossible to estimate the number of man-years of effort involved with secondary aspects of the project. It is estimated that eighty percent of the labor force would be drawn from regional or nationwide labor force and twenty percent from local areas.

8.OV Alternatives to the Proposed Action

Introduction

The proposed action and its objectives have various alternatives; some are available to the Secretary of the Interior, some to the Applicants, and some would involve such complex policy matters that their implementation would require Government-wide actions.

The Secretary of the Interior has three obvious alternatives: grant the right-of-way permits sought, deny them, or defer the decision.

Estimated gas deliveries by the proposed Arctic Gas System for 1980 and 1985 are shown in Table 8.OV-1.

Table 8.OV-1

Estimated Gas Deliveries 1980 and 1985, Arctic Gas System

Year	Canadian Arctic		Northern Border		West Coast Pipelines	
	Bcf/d	Trillion Btu/yr.	Bcf/d	Trillion Btu/yr.	Bcf/d	Trillion Btu/yr.
1980	3.5	1318	1.2	452	1.2	452
1985	4.5	1695	3.5	1318	2.4	904

Denial of permits would mean that the gas could not be transported by the proposed pipelines to market areas in southern Oregon, California, and a 29-state area of the north central and northeastern United States. If the gas is

not delivered, projected natural gas supplies would fall short of anticipated demand in the areas that would be supplied by the Arctic Gas System. This would lead to:

1. Use of other gas supplies
2. Substitution for the energy by utilizing alternative energy sources
3. Consideration of other routes or systems to transport the Alaskan gas to markets in the conterminous United States
4. Curtailment of gas supplies

8.OV.1 Alternative Energy Sources

Alternative sources of natural gas include both domestic and imported supplies.

In the past, natural gas consumed in the United States has been produced by conventional onshore and offshore oil and gas wells in the United States or supplied by overland pipeline imports from Mexico and Canada. The future United States gas supply will include liquefied natural gas (LNG) from regions that have large gas reserves but limited internal markets and substitute natural gas.

For several years these sources have not been able to meet the rapidly growing demand. Projected future demand and supply comparisons predict deficits of gas of 3.7 Tcf (trillion cubic feet) in 1975 and 20.1 Tcf in 1990 using "conservative realistic" estimates.

To achieve a balance between supply and consumption in the past few years, measures such as curtailment have been necessitated in response to the shortage of gas. There is now increased recognition that the gas shortage is serious and probably of long duration. Thus, steps to conserve gas and consumer requirements are becoming part of a continuing effort to minimize curtailments.

One measure that could be taken to alleviate the natural gas supply-demand imbalance is deregulation of new natural gas at the wellhead. Based on econometric models, it can be predicted that differential supplies of gas from the conterminous United States projected under a deregulation assumption would exceed the supplies that could be transported by the proposed Arctic Gas System.

The environmental impacts that would be associated with increasing domestic supplies of gas would center on increased production, both onshore and offshore. The prime impacts associated with importing LNG are the safety aspects of the tankers, and terminal operations connected with LNG transfer for shore storage tankers, gasification, and transfer to pipelines.

Energy from sources other than natural gas can be considered as an alternative to transporting Alaskan gas. Interfuel substitution and energy conservation can also alleviate the projected shortfall in gas supplies.

The total potential United States energy supply exceeds probable demand through the year 1990 and beyond subject to the important qualification that the hydrocarbon portion of the domestic energy resource base is heavily weighted by coal. Uranium supply could be limited under present nuclear

reactor technology, but may be extended almost indefinitely if breeder reactor technology is successful. Other key domestic energy resources, particularly natural gas and petroleum, are not as abundant and are not physically distributed within the regions that are the major consumers of these resources.

Total energy consumption in the United States during 1973 was equivalent to 75.6 quadrillion Btus (British thermal units) which includes 22.1 trillion cubic feet of gas. Under a "conservative realistic" situation gas consumption in the United States is projected to be 25.2 Tcf in 1990.

The United States is now energy deficient with respect to both natural gas and petroleum. In 1973, the net energy deficiency was equivalent to about 12 quadrillion British thermal units, representing mainly imports of 2,158 million barrels of oil and 950 Bcf (billion cubic feet) of natural gas and LNG. These imports were partially offset by exports of about 52 million tons of coal during the year.

Total remaining recoverable resources, discovered and undiscovered in the United States, are estimated to be the equivalent of 37.3 quintrillion Btu. This domestic resource

is heavily weighted by the coal component, which is about 85 percent.

Virtually all of the major energy resources currently in use are substitutable in a variety of uses in the energy markets. The factors affecting the use of a particular energy source are economics, availability, technology, environmental considerations, other social influences including preference, and administered restrictions or constraints. Considerable interfuel substitution is anticipated in projections of energy components to 1990 to make up for the anticipated shortfall in natural gas supply relative to requirements during that period.

A possible alternative to the delivery of Alaskan gas is the conservation of equivalent amounts of energy in the United States through administered, regulated, or voluntary programs. Energy conservation could be significant within the entire spectrum of energy supply and demand--including improvement in methods and efficiencies of energy exploration, development, projection, transportation, processing, transmission, foreign trade, marketing, and utilization. Conservation of scarce energy supplies can also be accomplished through interfuel substitution of more abundant or low cost energy resources such as coal.

Conservation measures outlined by President Ford in his State of the Union Message (January 15, 1975) would reduce oil imports by the equivalent of 2,021 trillion Btu during 1975-1976 and by 4,042 trillion Btu during 1976-1977. In comparison, in 1982, the gas delivered to the United States by the Arctic Gas Pipeline by 1985 would be equivalent to 1695 trillion Btu.

The potential for substitution of gas that could be transported by the Arctic Gas System by other energy sources can be evaluated in terms of energy equivalents required to replace the Arctic Gas, the resource base, economic and technologic feasibility, and environmental impacts.

In the following paragraphs evaluations of the various energy sources that have been considered in Part VI as possible alternatives to the Arctic Gas Pipeline System are summarized.

Coal

Coal is the most abundant fossil fuel in the Nation. Reserves are ample to meet the foreseeable domestic demand for the balance of the century and beyond. Surface mining of coal in the Rocky Mountain States would be the most

probable substitute for Alaska gas, particularly for gas supplies to the Western States. To replace the energy that would be delivered to the West Coast by the Arctic Gas System would require eight new strip mines with capacities of five million tons per year. The environmental impact of coal utilization for energy production would be related to the coal extraction (underground and surface mining); transportation of the coal; and coal conversion by either direct combustion or by conversion into synthetic fuels such as gas and liquids.

Petroleum

In recent years, domestic production of oil and gas has been steadily increasing in offshore locations. However, relating current usage to the Nation's resource base, petroleum and natural gas will be depleted much sooner than coal, and petroleum does not appear to be a realistic long-run substitute for deficiencies in natural gas.

Oil Shale

Large areas of the United States contain oil shale deposits. The areas with greatest potential for production are in Colorado, Wyoming, and Utah. Resources would be adequate to replace the energy equivalent to Arctic Gas. Barriers would be economic, technological, and environmental. Environmental impacts include effects of surface mining, transportation within and near mines, processing, and transportation of synthetic crude oil.

Synthetic Natural Gas and Oil

Through hydrogeneration processes, it is possible to convert coal to various hydrocarbon liquid and gaseous substitutes for natural oil and gas. The resource base for coal especially in the West would be adequate to provide feedstocks for synthetic natural gas to replace the Alaska gas. Water is an important element in coal gasification and obtaining adequate supplies of water may be a problem. The main barriers to oil shale development have been economics and technology. Most processes have not yet advanced beyond the pilot plant stage, have not been tested commercially, and have not been able to compete in cost with other energy

sources. In addition, coal gasification would require strip mining of large amounts of coal with the associated environmental problems.

Hydroelectric Power

Total conventional hydroelectric power potential of the United States at both developed and undeveloped sites is estimated to be about 179,000 megawatts (MW) of capacity. Present installations represent a large portion of the most attractive hydroelectric resources of the United States. Because the electricity which could be derived from the Arctic gas amounts to 159 billion kilowatt hours or 542 trillion Btu (assuming 40 percent conversion efficiency), the present and proposed-for-construction pumped storage capacity would not approach the capacity required to replace the Arctic Gas.

Geothermal Energy

The greatest potential for geothermal energy in the United States exists in the Rocky Mountain and Pacific Regions, with the Geyers Field in California leading in

development. The ultimate capacity of the Geyers Field is estimated to be in the 1,000 to 2,000 MW range. To substitute for the energy to be transported by the West Coast pipelines would require about 24 installations capable of producing 1,000 MW. Accelerated development of geothermal power could substitute for part of the energy to be transported by the Arctic Gas System, but would not be a realistic alternative to the system.

Nuclear Power

A marked increase in the use of nuclear energy in the future is anticipated as a partial solution to the present United States' energy problems. Installed nuclear capacity is now 25,000 MW. Under the most likely case, nuclear power growth is projected to increase to 132,000 MW in 1980 and to 1,200,000 MW by 2000. The total electric power that would be supplied by the energy equivalent to the gas that could be transported by the Canadian Arctic pipeline would be about 123,000 MW. It would take 8 nuclear power plants with three 1,000 MW units to a plant to produce this amount of energy.

Long-Term Energy Sources

Several energy sources offer a variety of potential advantages over the longer term. These include tar sands, biological energy, solar energy, tidal power, and wind power. While each of these could contribute to some degree to the Nation's total energy supply in the future, they have not been developed to a point of economic feasibility to be realistic alternatives to Arctic Gas within the timeframe of the project.

Conversion Techniques

Technology is currently under development for several methods of increasing the efficiency of converting energy to work. These conversion techniques include fuel cells, magnetohydrodynamics, thermoelectric, and thermionic. As in the case of the long-term energy sources, research on these techniques is proceeding slowly, and they have not been developed to a point of feasibility at the present time that would make them realistic alternatives to the Arctic Gas System.

8.OV.2 Alternative Transportation Modes

Alternative modes of transportation for the Arctic Gas include dense-phase and methanol pipelines, railway, monorail, ice-breaking tankers, submarines, airplanes, helifloats, and dirigibles. The gas could also be converted to electricity and transmitted via high voltage lines or transported by a combination of transportation modes. The system considered the most likely alternative would be a combination pipeline-LNG tanker system.

Dense-Phase Pipeline

The natural gas could be converted to its dense-phase, that is, natural gas in the single phase region by exhibiting properties between a liquid and a gas in the -115°F to -150°F temperature range and pressures from approximately 400 to 1,000 p.s.i.g. (pounds per square inch gauge), in plants that would be constructed near the gas producing areas. The gas could then be transported by pipeline and regasified at plants in southern Canada or the northern United States and distributed by conventional pipeline. A dense-phase pipeline has not yet been used commercially over great distances. In addition, the cost is

greater and the efficiency less than for a natural gas pipeline. Impacts on the environment would be those related to the refrigeration and regasification plants, as well as those of the pipeline itself.

Methanol Pipeline

The natural gas could be converted to a liquid alcohol or methanol in plants that could be constructed at the producing areas. It could then be transported as a liquid through pipelines and at its destination converted to synthetic natural gas or used directly as methanol. The methanol pipeline would be technically feasible, but would have a much lower efficiency and higher cost than a natural gas pipeline. Environmental impacts would result from the methanol plants, as well as the pipelines. In case of a leak, methanol would cause problems related to the fact that it would mix with groundwater.

Railway

Natural gas could be liquefied at the producing area and transported as LNG by railroad to southern Canada, where it

could be regasified for transport by conventional pipeline. Special railway equipment that would be needed for such a system has not yet been designed. Efficiency would be lower and costs higher for railway than for a natural gas pipeline. A major difference in impact would be that the railway would require about ten times more construction material than a pipeline.

LNG Monorail

A monorail system would be similar to a railway system, except that the actual transportation of the LNG would be by a high-speed magnetic levitation type of monorail system on double track elevated guideways. A monorail system is considered within the scope of current technology; however, current emphasis in research has been on mass-transit systems rather than cargo systems. An LNG system would require three to four times the amount of lift of systems currently being studied.

Ice-Breaking Tanker

Natural gas could be liquefied at plants in the producing areas and shipped by ice-breaking LNG or methanol tankers to East and/or West Coast ports in the conterminous United States. From there it would be distributed by conventional natural gas pipelines. Problems of designing and putting together an ice-breaking or methanol tanker system would require a longer time than needed for a natural gas pipeline system. Primary impact to the environment would result from construction of plants and safety aspects of tanker shipment.

Submarine

A system similar to the ice-breaking tanker could be used, except that shipment of LNG or methanol would be by submarine, rather than tanker. Because of lead time that would be needed for development, this system would take longer to implement than a natural gas pipeline system.

LNG Airplane

The natural gas could be liquefied near the producing areas and then transported by airplane, in pods attached to the wings, to plants where it would be regasified for distribution by pipeline. A high degree of uncertainty exists with design of the airplane that cannot be resolved without extensive engineering design efforts.

LNG Helifloat

The Helifloat is an aircraft being developed that combines characteristics of a helicopter, a buoyancy craft, and an airplane. The gas could be liquefied, transported as LNG by Helifloat and then regasified for distribution. The Helifloat itself is in a very early stage of development and many problems relating to the system would have to be solved if it were to be used to transport Arctic gas.

LNG Dirigible

Transportation of liquefied natural gas by large dirigible airships would be a possible alternative system. However, designs for this mode of transportation are not

even on the drawing board as yet and are probably ten years away from a possible use date.

Electrical Generation and Transmission

Natural gas from the producers could be converted by electrical generating plants fueled by natural gas to electricity, first to high-voltage alternating current as the plant output and then further converted to high-voltage direct current for transmission. At the market area the power could be converted to alternating current for distribution. The efficiency of this type of system is much less than for a natural gas system.

8.OV.3 Alternative Routes

In addition to the prime route selected for a pipeline by the companies, other alternative routes for construction of a pipeline system have been considered. Evaluation of the routes takes into account a combination of features, including length of the alternative routes, number of river crossings, length of wilderness areas crossed, length of areas where common corridors can be used and numerous other factors. The analyses generally showed that no one alternative route showed the most favorable combination of all of the features considered desirable and choice of route would have to depend on which factors were considered of most importance.

Four alternative routes that are common to both Alaska and northern Canada are considered. One is an offshore corridor that would include an underwater pipeline roughly paralleling the Arctic coastline north of the Arctic National Wildlife Range. A second is the Interior Route, which would roughly parallel the southwestern boundary of the Arctic National Wildlife Range. The third is the Fort Yukon Corridor, which would follow the Alyeska Pipeline south for about 100 miles and then go southeast toward the Fort Yukon area and rejoin the proposed prime route in

Canada about 1280 miles south of Richards Island. The fourth is the Fairbanks Corridor, which would follow the Alyeska Pipeline route for 520 miles. From there it would pass close to Fairbanks and follow the Alaska Highway into Canada past Whitehorse to Watson Lake, where it joins with the Fort Yukon Corridor.

In Alaska, a coastal route would follow the coastline through the Arctic National Wildlife Range to the Canadian border and rejoin the proposed prime route. In southern Canada and the Northern Border areas, various route alternatives have been considered.

Four alternative routes are common to both southern Canada and the Northern Border. The Liard River-Wolf Lake-Emerson-Red River Corridor begins at the Liard River in southern Canada and lies east of the proposed Canadian prime route. It crosses the United States-Canadian Border in western Minnesota and joins the proposed Northern Border route near Waterloo, Iowa. At Wolf Lake, the pipeline bifurcates with one leg going southwest to Kingsgate. A second corridor, the Edmonton-Regina-Red River Corridor, would parallel closely an existing oil line. It leaves the proposed prime route near Hay River and lies east of the proposed route. The route is west of the Liard River-Wolf

Lake-Emerson-Red River route in Canada, but joins it at the United States-Canadian Border. It bifurcates near Edmonton with one leg going southwest to Kingsgate. The Moose Jaw-Red River Corridor would follow the Trans-Canada Gas Pipeline east from a point on the proposed Canadian prime route near the Alberta-Saskatchewan Border. It would join the Edmonton-Regina Corridor just east of Regina and continue along the Red River Corridor. The Moose Jaw-Northern corridor would follow the Moose Jaw corridor for a distance and then would proceed southeast to join the Northern Corridor, described below, in central North Dakota.

Alternatives to the Northern Border route include the Mid-Route Alternative, the Southern Route, the Great Circle Alternative, and the North Missouri River Alternative. The Mid-Route Alternative lies south of the proposed route for 340 miles in Montana and North Dakota. The Southern Route goes further south and continues to lie south of the proposed route into central South Dakota. The Great Circle Route is a straight line route from the Canadian-United States Border to Kankakee, Illinois, and then coincides with the proposed route. The North Missouri River Alternative is north of the proposed route through Montana and North

Dakota, and turns southeast to join the proposed route near Waterloo, Iowa.

For the West Coast pipelines, two alternative routes were proposed by the Applicants. The West Alternative is approximately parallel to, but a short distance east of the proposed route. The East Alternative would cross the U.S.-Canadian border near Gateway, Montana further east of the proposed route and extend through western Montana, eastern Idaho and Nevada, then southwest to Cajon, California.

Two other alternatives affect both the San Francisco and Los Angeles pipeline proposals. One combines the two proposals into one system from the Canadian border to Los Angeles via Antioch, California, while the other combines the two proposals into one system from the Canadian border to the Snake River. These two alternatives would eliminate the need for construction of 1,120 miles and 206 miles of pipeline respectively.

Another alternative to the proposed system is the use of a smaller diameter pipe at the source (42-inch contrasted to 48-inch in the proposal). Corresponding reduced sizes are alternatives for the Northern Border and West Coast Pipelines.

An obvious major alternative to the Arctic Gas System is a combination of pipeline and LNG carrier modes. The El Paso Alaska Company and the Western LNG Terminal Company have applied to the Federal Power Commission for Certificates of Public Convenience and Necessity for such a system. The gas would be transported 809 miles across Alaska in a chilled 42-inch pipeline that would be built mostly within the Trans-Alaska Oil Pipeline Corridor with a terminal at Point Gravina on Prince William Sound. The gas would then be shipped by cryogenic tanker as liquid natural gas (LNG) to a receiving terminal and regasification facility at Point Conception, California. Upon regasification, the gas would be transported to existing facilities at Arvin and Cajon, California by proposed 42-inch pipeline.

In addition to this route, other possible routes in Alaska are from Prudhoe Bay to terminal sites at Cook Inlet, Haines, or Golovin Bay.

9.OV Consultation and Coordination with Others

The companies of the Arctic Gas System have developed proposals to transport natural gas from Alaska to the lower United States. These companies have filed applications with the Federal Power Commission and the Secretary of the Interior for various certificates and permits which are necessary before the proposals can be implemented.

The Arctic Gas System has been proposed by a consortium of 27 companies which now constitute the Gas Arctic-Northwest Project Study Group. The Study Group has caused the Alaskan Arctic Pipeline Company and the Canadian Arctic Pipeline Company to be formed and has contributed both in manpower and in money to those corporations which have applied for authority to make Arctic gas available to various market areas in the lower United States.

Table 9.OV-1 presents the relationship of the corporations in the study group to the applicant companies.

Table 9.OV-1
Arctic Gas System Applicants

Region	Applicant Companies	Corporations which have caused Applicant companies to be formed and method of formation
Alaska	Alaskan Arctic Pipeline Company	Formed by Arctic-Gas-Northwest Study Group
Canada	Canadian Arctic Pipeline Co., LTD	Formed by Arctic-Gas-Northwest Study Group
Northern Border	Northern Border Pipeline Company	The Northern Border Pipeline Company is a Partnership formed by the following corporations:
		-Columbia Alaskan Gas Transmission Company (an affiliate of Columbia Gas Transmission Corporation)
		-American Natural Gas Arctic Company (an affiliate of Michigan Wisconsin Pipeline Company)
		-NANBCO, Inc. (a subsidiary of Natural Gas Pipeline Company of America)
		-Northern Plains Natural Gas Company (a subsidiary of Northern Natural Gas Company)
		-Pan Border Gas Company (a subsidiary of Panhandle Eastern Pipeline Co.)
		-TETCO Three, Inc. (a subsidiary of Texas Eastern Transmission Corp.)
West Coast		
S.F. Line	Pacific Gas and Electric Company and Pacific Gas Transmission Company	The Pacific Gas & Electric Company owns 52.66% of Pacific Gas Transmission Company's Common Stock
L.A. Line Kingsgate to California border	Interstate Transmission Associates (Arctic)	-The Northwest Energy Company (a subsidiary of Northwest Pipeline Co.)
		-Pacific Interstate Transmission Company (a subsidiary of Pacific Gas Lighting Development Company)
California Border to Cajon, CA	Southern California Pipeline Company	Southern California Pipeline is a wholly-owned subsidiary of Pacific Gas Lighting Development Company

9.OV.1 Consultation and Coordination in the Development of the Proposal and in the Preparation of the Environmental Impact Statement

The proposals presently pending before the Department of the Interior and Federal Power Commission were developed exclusively by the applicant companies and without the direct involvement of the Federal Government. The information submitted by the Applicants to the Interior Department does indicate, however, that during the development of their applications and environmental reports, the Applicants did consult with the Federal agencies and bureaus which would have to issue permits and licenses were the proposals to be approved. Table 9.OV.1-1 summarizes the consultations and the nature of the approvals required.

The Applicants have indicated that they also contacted the agencies and bureaus listed below for general information:

Department of Labor

Department of State

Department of the Treasury

Department of Commerce

Department of Transportation

Office of Pipeline Safety
Coast Guard

Table 9.OV.1-1
Consultation By Applicant Companies With Federal Agencies Having Project Approval Requirements

Agency	Responsible Subdivision	Activity Requiring Approval	Form	Consultation By Applicant Companies				
				ALASKA	NBORDER	PCT	ITAA	SOCAL
Federal Power Commission		Construction and Operation of an Interstate Natural Cas Transmission Pipeline	Certificate of Public Convenience and Necessity	C			C	NA
		Construction, Maintenance and Operation of Facilities at the Canadian Border for the Importation/Exportation of Natural Cas	Presidential Permit	C			C	NA
		Importation/Exportation of Natural Cas	Authorization to Import/Export Natural Cas	C			C	NA
Environmental Protection Agency		Discharge of Water	Discharge Permit Where Applicable	C	C			
Federal Communications Commission	Safety and Special Radio Services Bureau	Installation and Operation of Microwave Transmitter and Associated Tower Facilities	Radio Station Authorization (Construction Permit and Station License)	C		NA	NA	NA
Department of Agriculture	Forest Service	Pipeline Construction across National Crass Lands Administered by the Forest Service	Special Use Permit and Right-of-way	NA	C	C	C	
Department of the Army	Corps of Engineers	Pipeline Construction across Navigable Waterways	Permit for Work in Navigable Waters	C		C	C	NA
Department of Transportation	Federal Aviation Administration	Installation of Microwave Transmission Towers	Per F.A.A. Circular No. AC-70-7460-2D	C		NA	NA	NA
Department of the Interior	Bureau of Indian Affairs	Pipeline Construction and Compressor Station Location on Tribal, Individually Owned and Covernment Owned Indian Lands Administered by the B.I.A.	Right-of-way and Decree	C			NA	NA
	Bureau of Land Management	Pipeline Construction across Public Lands Administered by the B.L.M.	Right-of-way and Special Use Permit	C	C	C	C	
	Bonneville Power Administration	Pipeline Construction across Electrical Transmission Lines	Right-of-way	NA	NA	C		NA
	Bureau of Reclamation	Pipeline Construction across Lands Administered by the Bureau of Reclamation	Easement	C	C		NA	NA
	Bureau of Sport Fisheries and Wildlife	Pipeline Construction across National Wildlife Refuge System Land Administered by B.S.F.W.	Right-of-way	C	C		NA	NA

Key: C - Applicant has consulted with appropriate agency
NA - Applicant has determined approval not applicable to its proposal.

Department of Agriculture

Soil Conservation Service

Department of the Interior

Bureau of Mines
National Park Service
Bureau of Outdoor Recreation

Federal Energy Administration

National Safety Council

Both the Federal Power Commission and the Department of the Interior determined that granting of the necessary permits and certificates would constitute a "major Federal action significantly affecting the quality of the human environment" and therefore would require an environmental impact statement. Both agencies determined, from the start, that a sound and comprehensive environmental analysis on the various proposals, when completed, would be useful and beneficial to the other Federal agencies and bureaus which would have to issue additional permits were either of the systems to be built.

Interstate natural gas transmission facilities are licensed by the Federal Power Commission through the issuance of a Certificate of Public Convenience and Necessity. The Secretary of the Interior has responsibility for issuance of right-of-way permits for pipeline

transportation of oil, natural gas, synthetic liquid, or gaseous fuels across Federal lands (Public Law 93-53). It was believed, therefore, that the applications pending before the Federal Power Commission and the Department of the Interior could be adequately discussed in one environmental impact statement.

A Memorandum of Understanding was executed by the Federal Power Commission and the Department of the Interior to prepare jointly a single environmental impact statement on the proposals for natural gas transmission facilities. The agreement was published in the Federal Register, page 26433, Volume 36, Number 140, Friday, July 19, 1974.

The rules of procedure of the Federal Power Commission (18 CFR 1.4 (d)) require that the preparation of the environmental impact statement be covered under the principle of *ex parte* communications. As a result, neither Department of the Interior nor Federal Power Commission personnel could communicate *ex parte* with any applicant or official intervenor during the time the Memorandum of Understanding was in effect. (*Ex parte* is literally defined as "one-sided". This rule precluded both oral and written communications concerning substance and merit of an

application without notification to all Applicants, intervenors or interested parties.)

In order to implement the terms of the Memorandum of Understanding, the Interagency Task Force established four subject-oriented work groups and four multidisciplinary support teams to gather and analyze information in the field and in defined geographic areas.

In developing the environmental impact statement, the field teams drew upon the following sources of information: the applications submitted by the companies; supplemental information filed by the companies in response to questions by the Task Force; field data provided by various agencies; work contracted to firms with special, technical expertise; and the original research, analysis and writing completed by the field team members.

A consolidated outline served as the primary mechanism for achieving an integration of the source materials and field drafts of the environmental impact statement. It was structured so that each section and subsection of the draft environmental impact statement could be assembled in a format which facilitated a "systems" analysis of the proposals or one which highlighted geo-political analysis.

The Memorandum of Understanding to prepare an environmental impact statement was predicated upon then existing applications of the Arctic Gas System (Arctic Gas) for Federal right-of-way permits and a Certificate of Public Convenience and Necessity to construct and operate a natural gas pipeline on a land-based route, and anticipated future applications of the El Paso Alaska Company (El Paso) for right-of-way permits and a Certificate to construct and operate a pipeline for a competing trans-Alaska water-based route.

El Paso filed an application with the Federal Power Commission for the applicable Certificate on September 24, 1974. The El Paso Company had indicated in press accounts and in various conversations that it intended to file an application with the Department of the Interior for the Federal right-of-way permits required to enable its use of Federal lands in Alaska. The Company, however, did not follow through with its announced intentions.

Under the provisions of amendments to the Mineral Leasing Act of 1920 (P.L. 93-153), the Department of the Interior is reimbursed by the Applicant for processing an application including the cost of an environmental analysis of a pending application. By not filing with the Department

of the Interior, the El Paso Gas Company prevented the Interior Department from evaluating that Company's proposal as a competing alternative delivery system.

The Department of the Interior requested that the Commission not take any action on the El Paso application unless or until the El Paso Company filed the requisite applications with the Interior Department.

On January 23, 1975, the Federal Power Commission issued an Order which denied the Interior Department's request. Thus, the applications pending before the Interior Department and the Federal Power Commission were no longer compatible for discussion in a single environmental impact statement. The Memorandum of Understanding for a joint environmental impact statement was subsequently abrogated February 20, 1975.

The Interagency Task Force and field teams were organized so that each would be able to conduct a multidisciplinary analysis of the companies' applications. The staffs were assembled by detailing personnel from the following agencies and bureaus:

Federal Power Commission

Department of the Interior

Bureau of Indian Affairs
Fish and Wildlife Service

Bureau of Land Management
Geological Survey
National Park Service
Bureau of Reclamation
Bureau of Outdoor Recreation
Bureau of Mines

Department of Agriculture

Forest Service
Soil Conservation Service
Institute of Northern Forestry

Department of Transportation

Federal Highway Administration
Federal Aviation Administration

In addition to the participation described above, personnel from the following Federal agencies and bureaus contributed to the environmental analysis of the proposal through preparation of sections of the draft environmental impact statement or in review or observer capacities:

Department of Transportation

Coast Guard
Office of Pipeline Safety

Department of Commerce

Maritime Administration
NOAA (National Weather Service)

Department of the Army

Corps of Engineers

In addition to the Interagency Task Force's consultation with the Washington office of the Federal offices listed

above, representatives of the Task Force addressed the Federal Regional Councils on the following dates and places:

Philadelphia, Pennsylvania	November 5, 1974
Chicago, Illinois	October 18, 1974
Denver, Colorado	October 15, 1974
San Francisco, California	October 1974
Seattle, Washington	September 1974

These councils represent all of the sections of the country which would be impacted by the proposals to transport natural gas from Alaska.

The regulations (36 CFR 800) of the Advisory Council on Historic Preservation require that the Council be informed as early as possible when a Federal undertaking will impact on any cultural resources, especially those eligible for inclusion on the National Register of Historic Places. The Task Force formally alerted the Advisory Council to the preparation of the draft environmental impact statement by a letter on February 28, 1975. As of April 9, 1975, the Interior Department had received no response from the Advisory Council.

Even though the Canadian segment of the proposal lies within the territory of another sovereign nation, it was considered necessary for the U.S. Government to analyze the environmental impacts of the Canadian segment in order to understand the full range of impacts which would be created

were the United States to give its approval to the proposals to transport natural gas from Alaska to market areas in the lower United States. In order to develop a working relationship with the Canadian Government, a series of meetings were held in the Spring of 1974 between representatives of the respective governments. It was agreed that the Interagency Task Force would not undertake independent studies beyond those performed by or on behalf of the Canadian Government as identified by the Pipeline Application Assessment Group or other duly constituted Canadian authorities nor would it request the Canadians to perform additional studies.

Once this understanding was reached through the Canadian Embassy, and materials provided, there were no further consultations with Canadian officials or individuals other than consultations with and through the Embassy staff. The working draft of the Canadian segment of the environmental impact statement was sent to the Canadian Embassy for review and comment before the draft was filed with the Council on Environmental Quality.

9.OV.2 Public Participation in the Preparation of the Environmental Impact Statement

In order to give persons and organizations the opportunity to comment in advance on what they believed the environmental impacts of the proposed actions would be, the Task Force, in January 1975, held information gathering meetings at eleven locations throughout the country. These meetings not only alerted the writing teams to the general concerns regarding the proposed gas transmission facilities, but also generated a large amount of information which centered on localized, specific environmental impacts.

The information gathering meetings were held in the following places:

Area and City	Date
Alaska	
Anchorage	January 10, 1975
Fairbanks	January 8, 1975
Juneau	January 6, 1975
Northern Border	
Billings, Montana	January 7, 1975
Chicago, Illinois	January 9, 1975
Bismarck, North Dakota	January 15, 1975
West Coast	
Sacramento, California	January 7, 1975
Portland, Oregon	January 9, 1975
Spokane, Washington	January 13, 1975
Reno, Nevada	January 15, 1975
Washington, D.C.	January 7, 1975

Each meeting had a morning, afternoon, and evening session so that the largest number of people could take part. Three hundred and eighty (380) people attended the eleven (11) public meetings at which a total of thirty-six (36) written statements were given and thirty-eight (38) oral statements were made. The oral statements and comments were either tape recorded or transcribed by a court reporter. Both the oral and written comments have been made a part of the public file. (Department of the Interior, Room 1540, Washington, D.C.; Federal Power Commission, Office of the Secretary, Washington, D.C.) These statements were also forwarded to the coordination staff in Washington, D.C. and to the appropriate writing teams so that they could be considered in the preparation of the draft statement.

An additional period of time was set aside after the information gathering meetings to allow persons to comment further on the environmental impacts. To insure maximum consideration it was suggested that they be filed by January 15, 1975, but no matter when they were received, they were given consideration by the writing teams. During this period, approximately 130 written comments were received by the Task Force. They have also been placed in the public file at the Department of the Interior.

In order to make sure a wide cross-section of groups and individuals were notified of the opportunity to participate in the information gathering meetings, the Task Force distributed an information packet which outlined the scope of the proposed action and invited persons to participate in the information gathering meetings or submit comments directly to the Task Force.

These packets were distributed to: 1,500 private groups and individuals; the Federal Power Commission's list of all intervenors in any of the Arctic Gas System dockets; and the Federal officials and Governors of those states which could be impacted by the proposals.

In addition to the mailings described above, a Notice was published in the Federal Register which notified interested parties of the upcoming information gathering meetings.

9.OV.3 Procedures to be Used in Disseminating the Draft Statement

The draft environmental impact statement will be filed with the Council on Environmental Quality and widely circulated simultaneously to interested persons, organizations, and governmental jurisdictions. The list of organizations, government jurisdictions, and individuals who have requested copies of the draft statement are contained in Part VII.

The review period will allow the draft statement to be reviewed as widely and comprehensively as possible.

About sixty days after the release of the statement, public hearings will be held in various locations to receive comments on the draft environmental impact statement.

Hearings will be held in:

Anchorage, Alaska
Juneau, Alaska
Fairbanks, Alaska
Portland, Oregon
Spokane, Washington
Sacramento, California
Reno, Nevada
Billings, Montana
Bismarck, North Dakota
Chicago, Illinois
Washington, D. C.

The times and locations of the above meetings and any additional hearings which may be scheduled will be published

in the Federal Register at least 30 days before the first hearing.

Subsequent to the hearings, an additional period of time will be allowed for individuals and organizations to file written comments with the Department of the Interior. In accordance with the Council on Environmental Quality Guidelines, comments on the draft statement will be included in the final environmental impact statement.

After the release of the draft environmental impact statement it will be available for review at the following places; the companies' applications are also available for review at the same offices:

ALASKA:	Bureau of Land Management Alaska State Office 555 Cordova Street Anchorage, Alaska 99501
WEST COAST:	Bureau of Land Management Oregon State Office 729 N.E. Oregon Street Portland, Oregon 97208
	Bureau of Land Management California State Office Room E-2841 2800 Cottage Way Sacramento, California 95825
	Bureau of Land Management Nevada State Office Room 3008 300 Booth Street Reno, Nevada 89502

NORTHERN BORDER:	Bureau of Land Management Montana State Office 316 N. 26th Street Billings, Montana 59101
	Office of the Special Assistant to Secretary of the Interior 32nd Floor 230 S. Dearborn Street Chicago, Illinois 60604
WASHINGTON, D.C.:	Department of the Interior C Street, between 18th & 19th Streets, N.W. Room 1540 Washington, D.C. 20240

Also, copies of the draft environmental impact statement will be sent throughout the country to depository libraries designated to receive and store governmental publications.

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GLOSSARY

active layer--The top layer of ground above the permafrost table that thaws each summer and refreezes each fall.

alluvial fan--A low, relatively flat to gently sloping deposit of alluvium shaped at the surface like an open fan (but actually a segment of a cone) and laid down by a stream at the place where it issues from a narrow mountain valley upon a plain or broad valley.

alluvial plain--1. Flood plains produced by the filling of a valley bottom are alluvial plains and consist of fine mud, sand, or gravel. 2. A plain resulting from the deposition of alluvium by water.

alluvium--Unconsolidated geologic materials deposited from the running water in which they were transported.

annular ice bulb (frost bulb)--Ring of frozen soil surrounding a chilled pipeline in unfrozen ground.

aquifer--A rock formation, bed or zone containing water that is available to wells. An aquifer may be referred to as a water-bearing formation or water-bearing bed.

artesian--Involving, relating to, or supplied by the upward movement of water under hydrostatic pressure in rocks or unconsolidated material beneath the earth's surface.

aufeis--A German term for a sheet of ice formed on a river flood plain in winter when shoals in the river freeze solid or are otherwise dammed so that water spreads over the flood plain and freezes.

backfill--Earth or other material used to replace material removed during construction, such as in pipeline ditches.

backhoe--An excavating machine whose bucket is attached to a hinged stick on the boom and is drawn toward the machine in operation.

badland--A region characterized by the intricate and sharp erosional sculpture of generally weak rocks usually forming nearly horizontal beds, generally developing in decomposed granite, loess, or other soft material, lacking or having only scanty vegetation, and consisting of steep, furrowed, or fantastically formed hills, labyrinthine drainage, and normally dry watercourses or arroyos.

bedrock--Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

bench--A long, gently sloping, nearly plane surface bounded on one side by a steeper rising slope and on the other by a steeper descending slope, generally parallel to a

stream course or a coastline; formed by stream or marine erosion or deposition.

berm--1. An embankment of fill extending from the riverbank used as a working surface for the crossing installation. 2. A slight mound of earth or rock over a pipeline.

bifurcation--Point at which a linear feature (stream, highway, etc.) divides or forks into two branches.

bituminous coal--Coal that contains 15-20 percent volatile material; synonymous with "soft" coal.

blowdown--1. Clearing of gas from pipeline by blowing it into the atmosphere. 2. A pipe or valve used to vent gas to the atmosphere. 3. The procedure whereby the gas pressure is intentionally reduced in a section of the line by venting. It is accomplished by the operation of valves and closure fittings provided in each block valve assembly.

bog--Peat-covered or peat-filled area with a high water table but little standing water, usually covered by peat moss, heaths and black spruce.

bolt-on river weights--Concrete weights that are bolted or clamped in place around pipe traversing rivers and streams to counteract tendency to float.

boreal--A zone encircling the globe south of the Arctic where forests are usually formed by a very limited number of species belonging to a few coniferous and hardwood genera including spruce, larch, pine, fir, birch, poplar, alder.

borrow--Any earthen, granular, or rock material taken from one area for use in another.

boulder effigy--A boulder shaped like an animal (as a bird or serpent).

braided river or stream--1. A braided stream is one flowing in several dividing and reuniting channels resembling the strands of a braid, the cause of the division being the obstruction by sediment deposited by the stream. 2. Where more sediment is being brought to any part of a stream than it can remove, the building of bars becomes excessive and the stream develops an intricate network of interlacing channels, and is said to be braided.

breaks--A line of cliffs and associated spurs and small ravines (as at the edge of a valley or canyon).

breakup--In general, the spring melting of snow, ice, and frozen ground. Specifically, the destruction of the ice cover on rivers during the spring thaw; or applied to the time when the solid sheet of ice on rivers breaks

into pieces that move with the current. Breakup connotes the end of winter to residents of the north.

carbonate--In a geologic sense refers to sedimentary rocks mainly composed of calcium or magnesium carbonates.

cathodic protection--A system consisting of a D.C. power source, ground beds, and connecting wiring designed to produce electrical potentials on the pipeline whereby the pipeline acts as a cathode and is thus protected from corrosion.

Cenozoic--In geological terms, pertaining to the present era, beginning 70 million years ago and characterized by the appearance of mammals.

chemosensory--Reacting to or sensitive to a (particular) chemical.

climax--The relatively stable, terminal plant and animal community of a successional series which is in a state of dynamic equilibrium with the regional climate.

compressor--A piece of machinery used for increasing the pressure of a gas.

compressor station--A facility which supplies the energy to move gas in transmission lines or into storage by increasing the pressure.

condensation nuclei--See ice fog.

construction spread--See spread.

conterminous United States--Those states of the United States in North America south of the Canada-U.S. boundary.

continuous permafrost--Permafrost occurring everywhere beneath the exposed land surface throughout a geographic regional zone with the exception of widely scattered sites, such as newly deposited unconsolidated sediments, where the climate has just begun to impose its influence on the ground thermal regime and will cause the formation of continuous permafrost.

coteau--A hilly upland separating two valleys.

coulee--A stream-cut, ravine or gulch, usually dry.

creep--A gradual usually downhill shifting or movement (as of loose rock, soil, sand or shale) that is due mainly to gravity together with freezing and thawing or wetting and drying.

cryogenic--Conditioned for use at very low temperatures.

culvert--A waterway, trench, or artificial channel.

db--See decibel.

db(A)--A unit for measuring sound which takes into account the frequency of a sound as well as the intensity. See also decibel.

decibel--A unit for measuring the relative loudness of sounds equal approximately to the smallest degree of difference of loudness ordinarily detectable by the human ear, the range of which includes about 130 decibels on a scale beginning with 1 for the faintest audible sound.

deep creep--See creep.

dendritic(drainage pattern)--Characterized by irregular branching in all directions with the tributaries joining the main stream at all angles.

dimension stone--Stone cut to pieces of specified size.

dense-phase--This term is applied to fluids that are in a single phase but exhibit properties between those of a liquid and a gas. Natural gas exhibits the dense-phase property within a pressure range of approximately 400 to 1,000 pounds per square inch gauge, and a temperature range of approximately -115°F to -150°F.

discharge--In its simplest concept discharge means outflow; therefore, the use of this term is not restricted as to course or location, and it can be applied to describe the flow of water from a pipe or from a drainage basin. If the discharge occurs in some course or channel, it is

correct to speak of the discharge of a canal or of a river.

discharge, sediment--See sediment discharge.

discontinuous permafrost--Permafrost occurring in some areas beneath the ground surface throughout a geographic regional zone where other areas are free of permafrost.

dissolved solids--Total quantity of solids present in solution quantitatively expressed as milligrams per liter. Typically the residue of evaporation.

dragline--An excavation machine in which the bucket is attached only by cables and is drawn toward the machine during the excavation or filling process.

dry farm--To farm without irrigation.

easement--An interest (usually nonprofitable) granted by deed or other legal instrument that is held by one person or entity in land owned by another and that entitles its holder to a specific limited use.

ecosystem--A natural, integrated, self-sustaining community of organisms interacting with each other and their total abiotic environment in a dynamic system independent of all external energy and material sources except the input of solar radiation.

endemic--Any kind of organism restricted to a single limited, and often local, geographic area.

escarpment--1. A steep face terminating high lands abruptly. 2. A slope; a steep descent. Geol.: The steep face frequently presented by the abrupt termination of stratified rocks.

fault--A surface or zone of rock fracture along which there has been movement; total movement may have been from microscopic to many miles in scale.

fault zone--Breaks in the earth's crust which are known to be subject to movement.

fauna--The total kinds of animals inhabiting an area at a given time.

feedstock--A raw material.

fen--Peat or peat-filled area with the water table at or near the surface dominated by a sedge, grass and reed community, sometimes with shrub cover and a scanty tree layer.

flood plain--A strip of relatively smooth land bordering a stream, built of sediment carried by the stream and dropped in the slack water beyond the influence of the swiftest current.

fluvioglacial--Pertaining to the meltwater streams flowing from a glacier and especially to the deposits produced by such streams.

fold--A curve or bend in a planar geologic element such as a stratum or joint.

folding--The curving or bending of a planar feature, such as a stratum; see fold.

forb--Any herb other than grass.

frost boil--An accumulation of excess water and mud liberated from ground ice by accelerated spring thawing, commonly softening the soil and causing a quagmire.

frost bulb--See annular ice bulb.

frost heaving--The lifting of a surface by the internal action of frost. It generally occurs after a thaw, when the soil is filled with water droplets and when a sudden drop in the surrounding temperature below freezing changes the droplets into ice crystals, which involves expansion, and consequently causes an upward movement of the soil.

fugitive dust--Dust that moves from place to place.

gathering station--Place where gas is gathered from underground gas storage or from a producing natural gas

field and inserted into the pipeline transmission system for distribution.

geomorphic--Of or relating to the form of the earth.

geothermal--Of or pertaining to the internal heat of the earth.

geotechnical--In this environmental statement, refers to the application of scientific methods and engineering techniques to the exploitation and utilization of natural resources.

glacial till--See till.

graben--A depressed segment of the earth's crust bounded on at least two sides by faults and generally of considerable length as compared with its width.

groundwater--Water in the ground that is in the zone of saturation, from which wells, springs, and groundwater runoff are supplied.

grouting--The process of injecting a thin fluid mixture cement into foundations for reinforcing or strengthening them and into mass fills for stabilization.

hardness--The quality in water that is imparted by the presence of dissolved salts.

herbaceous--Pertaining to herbs or to vegetation composed of non-woody species, as Herbaceous Coastal Tundra of grasses and sedges.

herbivore--An animal that feeds on plants; a grazing animal.

Holocene--Recent (in geologic terms).

hydrostatic test--The application of a predetermined fluid pressure to the interior of a pipe to test its ability to withstand the specified test pressure over a prescribed time period.

ice bulb--See annular ice bulb.

ice fog--A phenomenon peculiar to arctic and subarctic regions. While normal fogs are concentrations of water droplets, ice fogs are one step beyond--the water has frozen. Three factors are necessary for ice fog to form; (a) a temperature lower than -25°F, (b) a source of water, and (c) particulates in the air that form nuclei for droplets and ice particle formation (condensation nuclei).

ice-rich soil--Perennially frozen ground that contains ice in excess of that required to fill pore spaces.

ice wedge--A massive, generally wedge-shaped body with its apex pointing downward, composed of foliated or layered, vertically oriented, commonly white ice.

ice-wedge polygon--Any polygonally shaped piece of ground bounded by ice wedges; commonly from a few to several tens of feet in diameter.

icing--A mass of surface ice formed by successive freezing of sheets of water that seep from the ground, from a river, or from a spring. River icings are formed from waters of the river itself, building up over the existing river ice and sometimes extending beyond the river channel onto the flood plain. Ground icings are formed on the ground surface when an obstruction blocks normal ground water flow. Spring icings are formed by water flowing from a spring.

indurated--Rendered hard; confined in geological use masses hardened by heat, baked, etc., as distinguished from hard or compact in natural structure. In modern usage the term is applied to rocks hardened not only by heat, but also by pressure and cementation.

intercalate--To insert between layers or beds of other rock.

inversion, temperature--A condition in which warmer air is above a layer of cooler air.

lacustrine--1. Produced by or belonging to lakes. 2. Of, or pertaining to, formed, growing in, or inhabiting, lakes.

lichen--Any plant of the class Lichens, varying in size, form and color but always having a compound structure consisting of an algae and a fungus. A lichen is an air plant which lacks roots, stems, branches, leaves, and flowers.

lignite coal--A brownish-black coal in which the alteration of vegetal material has proceeded further than in peat but not so far as subbituminous coal; has a lower heating value than subbituminous coal.

liquefied natural gas (LNG)--A clear, flammable liquid principally composed of methane. Natural gas must be cooled to -260 degrees Fahrenheit in order to produce LNG and its volume occupies 1/600 of the volume of gas.

liter--1.0567 U.S. liquid quarts.

loess--A widespread, homogeneous, commonly nonstratified, unconsolidated but slightly coherent deposit generally laid down by the wind and consisting predominantly of silt with subordinate grain sizes ranging from clay to fine sand.

loop--New section of pipeline that is parallel to the existing pipeline.

low ground-pressure vehicles--Sometimes referred to all-terrain vehicles; vehicles which exert a small number of pounds per square inch of tire or track surface.

mass wasting--Movement of material down a slope by the force of gravity.

metamorphic, metamorphosed--Refers to rock changed by pressures, heat, and/or water from beneath the earth's surface.

methanol--Methyl (wood) alcohol.

micromho--A millionth of a mho (a unit of electrical conductance as opposed to ohm which is a unit of resistance).

microwave--An electromagnetic wave of extremely high frequency, usually having wavelength of from 1mm to 50 cm.

microtine--Pertaining to any member of the subfamily Microtine, a group of small to medium-sized northern rodents including voles, lemmings, and the muskrat.

midden--A refuse heap.

moraine--A mound, ridge, or other distinct accumulation of unsorted, unstratified glacial drift, predominantly till, deposited chiefly by direct action of glacier ice in a variety of topographic landforms that are

independent of control by the surface on which the drift lies.

M.P.--Mile Post

muck--Unconsolidated mixture of silt and well decomposed organic material.

mudstones--A term originally applied by Sir Roderick Murchison to certain dark-gray, fine-grained, shivery shales of the Silurian system in Wales, which, on being exposed to the atmosphere, are rapidly decomposed and converted into their primitive state of mud; but now extended to all similar shales in whatever formation they may occur; mudstone includes clay, silt, siltstone, claystone, shale, and argillite.

muskeg--A characteristic feature of northern topography. From the International Boundary to the Arctic Sea the term applies to alluvial areas with insufficient drainage, over which moss has accumulated to a considerable depth. These swamps are usually covered with tamarack and fir trees. The typical muskeg is traversed by meandering streams, having deep channels but a scarcely perceptible current. Stagnant pools become coated over with a moss of sufficient strength to

temporarily sustain the weight of a man. In places the surface is broken by tall hummocks.

omnivore--An animal that feeds on both plants and other animals.

oscillate--To swing or move to and from as a pendulum does.

outwash--1. Stratified unconsolidated deposits composed chiefly of sand and gravel that have been removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the terminal moraine or the margin of an active glacier. 2. Soil material washed down a hillside by rainwater and spread upon the more gently sloping adjacent land.

oxbow--A crescent-shaped lake formed in an abandoned river bed which has become separated from the main stream by a change in the course of the river.

paleontological--Of or pertaining to the study of the forms of life existing in former geologic periods.

particulate matter--Minute separate particles; with respect to air pollution, these particles are airborne.

particulates--See particulate matter.

patterned ground--In the Arctic, polygonally marked flats and stone-striped hillsides resulting from frost action and ice wedging.

peat--Partially decomposed plant remains preserved as organic deposits largely under anaerobic (without oxygen) conditions of wetlands; also accumulating in cold climates by low temperature preservation.

permafrost--Soil, rock, or any other earth material whose temperature remains below 32°F (0°C) continuously for 2 or more years. Permafrost results solely from below-freezing temperature, irrespective of the texture, degree of compaction, water content, or lithologic character of the frozen materials involved.

petroglyph--A carving or inscription on a rock.

pH--A measure of hydrogen ion concentration, indicating degree of alkalinity or acidity.

physiographic province--A large area having generally uniform topography, geology and climate.

pictograph--An ancient or prehistoric drawing or painting on a rock wall (as of a cave or cliff).

pig--A spherical or cylindrical device pushed through a pipeline to remove liquids (including hydrostatic test water) or other foreign contaminants.

pingo--An Eskimo term for a conical, commonly more or less asymmetrical mound or hill, with a circular or oval base and commonly a fissured summit, occurring in the

continuous and discontinuous permafrost zones, which has a core of massive ground ice covered with soil and vegetation, and which exists for at least two winters.

polygon--Soil pattern produced on level ground by alternate freezing and thawing of the surface soil above the permanently frozen level. See also ice-wedge polygon.

pothole--A body of water of limited extent, frequented by wildlife.

predator--An animal preying on other animals; a secondary or tertiary consumer in the food web.

pressure limiting station--Equipment that prevents pressure in a pipeline from exceeding the maximum allowable operating pressure by controlling the flow of gas.

pressure relief station--Equipment that prevents the pressure in a pipeline from exceeding the maximum allowable operating pressure, by venting gas to the atmosphere.

productivity--Pertaining to ecological communities or ecosystems, the rate at which energy is stored by photosynthetic and chemosynthetic activity of producer organisms (chiefly green plants) in the form of organic substances which can be used as food materials.

projectile point--A point such as an arrowhead or spearhead that is attached at the front of a weapon to be hurled, thrown or projected with force.

prove--In economic geology, to establish by drilling, trenching, underground openings, etc., that a given deposit of a valuable substance exists (and where), and that its grade or tenor and dimensions equal or exceed some specified amounts.

proven reserves--Mineral reserves, especially of crude oil, natural gas liquids, and natural gas, for which reliable quantity and quality estimates have been made.

Quaternary--The second period of the Cenozoic era (following the Tertiary), thought to cover about the last two million years.

radiational cooling--Cooling of the air layer close to the ground, caused when the ground has lost heat due to ground radiation and is cooler than the air above.

raptor--Bird of prey, as falcon, hawk and eagle.

regulation--In hydrology, the artificial manipulation of the flow of a stream.

relief--Difference in elevations of high and low points of the area or region under discussion.

reserves--Amounts of mineral commodities (including fuels) identified and remaining in the ground. Reserves may be total or recoverable; the latter is that portion of the total that is capable of being produced using currently known techniques.

Richter scale--The range of numerical values of earthquake magnitude. In theory there is no upper limit to the magnitude of an earthquake, but the strength of earth materials produces an actual upper limit of slightly less than 9. The scale is logarithmic.

riprap--Blocks of rock or concrete, commonly of irregular shape, used to armor parts of stream banks, shorelines, or artificial embankments against erosion.

river weights--Concrete weights that are bolted or clamped in place around pipe traversing rivers and streams to counteract tendency to float.

runoff--That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on the stream channels.

saddle weights--Weights, usually of concrete, that straddle pipe, and which have no clamps or bolts, that are used to counteract tendency to float.

salmonid--A fish of the salmon family (Salmonidae), as salmon, trout, char and whitefish.

scabland--An elevated tract of bare or shallow-soiled rocky land (as the top of a butte or mesa) in the Northwest caused especially (as on the Columbia lava plateau) by denudation of the soil mantle or prevention of its formation.

scour--Erosion or wearing away caused especially by moving water or friction of rough materials.

scraper trap--A receptacle for sludge cleaned from a pipeline.

sea ice--Within polar regions the surface of the sea freezes during the long winter season, the product being known as sea ice or field ice.

sedge--A grass-like plant in appearance, belonging to the family Cyperaceneae.

sediment--Fragmental material that originates from weathering of rocks and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural agencies.

sediment discharge--The rate at which dry weight of sediment passes a section of a stream; or the quantity of

sediment, as measured by dry weight, or by volume, that is discharged in a given time.

sediment yield--Sediment discharge at a point, measured in either weight or volume of sediment per unit area of the contributing drainage area upstream per unit of time. Sediment yield often represents a quantity of sediment retained in a reservoir or other catchment structure.

sedimentary--Descriptive term for rock formed of sediment, especially: (1) Rocks, such as conglomerate, sandstone, and shales, formed of fragments of other rock transported from their sources and deposited in water. (2) Rocks formed by precipitation from solution, as rock salt and gypsum, or from secretions of organisms, as most limestone.

sedimentation--The action or process of depositing sediment.

seed set--Adherence to a parent plant and initiation of growth or normal development as a result of a stimulus (such as pollination).

seismic--Pertaining to an earthquake or earth vibration.

seismicity--1. The phenomenon of an earthquake or earth vibration. 2. The frequency, intensity, and distribution of earthquakes in a given area.

select backfill--Backfill for which a specification has been established setting gradation limits and/or composition.

shale--Fine-grained sedimentary rock composed of clay-sized and silt-sized rock fragments characterized by thin layering.

silt--1. Material made up of rock fragments between 0.00016 and 0.00025 inch in diameter. 2. Soil consisting of 80 percent or more silt (.05-.002 mm.) and less than 12 percent clay.

SMSA--Standard Metropolitan Statistical Area. An integrated urban area according to specific U.S. Census Bureau criteria as to population and urban character.

snow road--A temporary access road constructed by leveling and packing snow to provide a surface of the required depth and density for support of traffic.

sodic--Of, relating to, or containing sodium.

solifluction--A naturally occurring process of slow, gravitational, downslope movement of saturated, nonfrozen earth material behaving as a viscous mass over a surface of frozen material.

sound attenuation--A reduction in sound level.

specific conductance--A measure of the ability of a given substance to conduct electric current.

specification--A detailed description of requirements, dimensions, materials, etc., as of a building, machine, bridge or other structure.

speculative reserves--See speculative resources.

speculative resources--Undiscovered materials that may occur either in known types of deposits in a favorable geologic setting where no discoveries have been made, or in as yet unknown types of deposits that remain to be recognized. Exploration that confirms their existence and reveals quantity and quality will permit their reclassification as reserves or identified-subeconomic resources.

spread--A group of workers and necessary equipment organized to handle all phases of construction for a given pipeline section.

spoil--Any earth or rock material that has been excavated.

staging--The assembling of flocks of birds in preparation for migration.

steppe--Arid land characterized by vegetation requiring minimal moisture and usually found in large tracts and in regions of extreme temperature range and loess soil.

STOL aircraft--An aircraft that has short takeoff and landing characteristics. Normally, STOL aircraft require runways of approximately 2,000 feet or less.

streamflow--May be the same as runoff but as a more general term includes flow affected by diversion or regulation.

subbituminous coal--Black coal similar to lignite, but with higher carbon and lower moisture contents than lignite and a lower heating value than bituminous coal.

subsistence--As applied to hunting and fishing, entails use of animals and fish for direct maintenance of life rather than for recreational purposes or for disposal of products for some other medium of exchange.

substrate--The physical surface upon which an organism lives.

surface water--Water as in lakes, rivers, and streams above ground as opposed to groundwater which occurs underground.

tap--Point of connection or delivery of gas to a smaller pipe.

Tertiary--The first period of the Cenozic era from between 63 to two million years ago.

thaw lake--In regions underlain by permafrost, a shallow body of water whose basin is produced by settlement of the ground following thawing of ground ice.

thermal--1. Of, relating to or caused by heat. 2. Of or relating to hot springs or geysers.

thermokarst--The irregular topography resulting from differential thaw settlement or caving of the ground because of the melting of ground ice in thaw-unstable permafrost.

throughput--The quantity of natural gas or other product transported by pipeline.

till--Unsorted and unstratified drift, generally unconsolidated, deposited directly by a glacier without subsequent reworking by water, and commonly consisting of a heterogeneous mixture of clay, silt, sand, gravel, and boulders varying widely in size and shape.

train--See valley train.

tuff--A rock composed of the finer kinds of volcanic detritus, usually more or less stratified and in various states of consolidation.

tundra--An ecosystem characterized variously by low-growing vegetation of mosses, lichens, grasses and sedges, and dwarf shrubs; such animals as lemmings and other

microtine rodents, caribou, musk oxen and grizzly bear; occurring in the Arctic beyond the latitudinal limit of trees and in mountains above timber line; having a muck soil and permanently frozen subsoil.

turbidity--A condition of opacity or murkiness of a stream caused by sediment or suspended matter.

unindurated--See indurated.

valley train--A long, narrow body of outwash, deposited by meltwater streams beyond the terminal moraine or the margin of an active glacier and confined within the walls of a valley below the glacier.

valve--A mechanical device used to start, stop, or regulate the flow of gas through the pipeline.

venting--Releasing gas in a pipeline section to the atmosphere through valves. May also be called blowdown.

vision quest--A solitary vigil by an adolescent American Indian boy to seek spiritual power and learn through a vision the identity of his guardian spirit, usually an animal or bird.

wage economy--An economic system based on payment for goods and services in a monetary medium of exchange; opposed to barter or complete self-support; equivalent to cash economy.

wash--The dry bed of an intermittent stream.

wetlands--Any terrain having the water table at or near the ground surface.

working age population--All persons between ages 15 and 64 (Canada report).

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